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ALIEN HAND SYNDROME

AND OTHER TOO-WEIRD-NOT-TO-BE-TRUE STORIES

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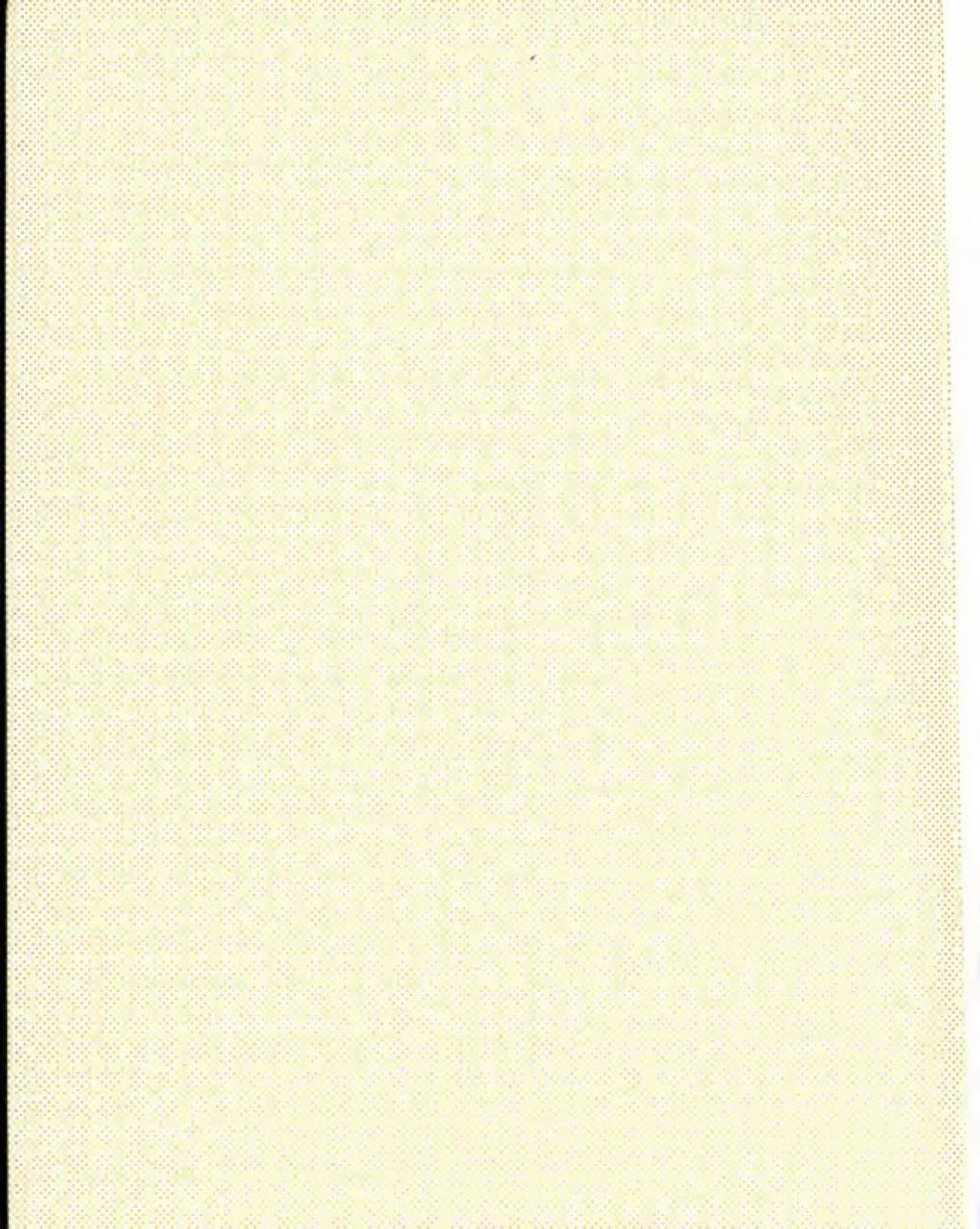
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Watch Out! A rebel limb has a mind of its own in the mysterious Alien Hand Syndrome, first reported in 1908. page 2

duplicates. Where a woman falls 33,330 feet out of a jetliner and lives. Where carnivorous centipedes long as a man's forearm crawl through the night looking for living flesh. Welcome to the world of Damn Interesting.

By ALAN BELLows AND THE EDITORS
OF DAMN INTERESTING



ALIEN HAND SYNDROME

ORIGINAL
IMPROVEMENTS

ALIEN HAND SYNDROME

AND OTHER
TOO-WEIRD-NOT-TO-BE-TRUE STORIES

By Alan Bellows
and the Editors of DAMN INTERESTING

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**Dedicated to the dedicated readers of Damninteresting.com,
without whom none of this would have been plausible.**

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It was during a typical, drab October evening when I became the recipient of what appeared to be a typical, drab "Google Alerts" e-mail. It included a short list of websites that had linked to DamnInteresting.com in recent weeks, and as usual the list was made up of several tasteful and discerning websites: Reddit.com, MetaFilter.com, BoingBoing.net, Cellar.org, Wikipedia.org, and similar sites from which a mere link is a great compliment. However, one link in particular snagged my eye. Much to my delight, Scott Adams of *Dilbert* fame had linked to one of my articles in his frequently fascinating Dilbert blog. I dashed off a quick thank-you e-mail, resulting in an exchange that rapidly cascaded into a chain of events that led to a book deal with Workman Publishing. For this initial assistance and encouragement, we extend our sincere thanks to Mr. Adams.

We also owe an enormous debt of gratitude to the intrepid readers of DamnInteresting.com for keeping us furnished with insightful comments, lively debate, topic suggestions, and moral support. Your intellect and wit elevated the site to something greater than we could have produced on our own. Also, super-duper thanks to those benevolent humans who donated funds to help us launch our initial book effort . . . as writers, we are giddy at the prospect of seeing our works adorning the shelves of bookstores, and you have done much to help us get there.

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INTRODUCTION

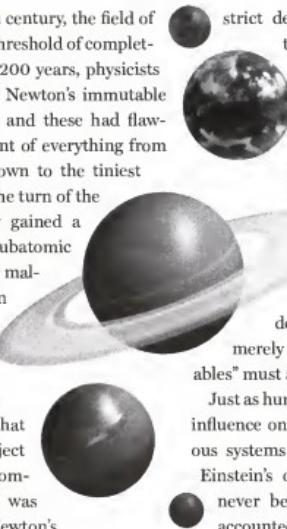
THE BIG BOOK THEORY

“We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.”

—PIERRE-SIMON LAPLACE, 1814

Toward the end of the 19th century, the field of physics seemed to be on the threshold of completing its work. For more than 200 years, physicists had been applying Sir Isaac Newton's immutable laws of gravity and motion, and these had flawlessly predicted the movement of everything from the largest known bodies down to the tiniest observable objects. Around the turn of the century, however, humanity gained a deeper understanding of the subatomic realm, and a gaggle of brainy malcontents pried the lid off a can of worms known today as *quantum mechanics*.

Among other seemingly preposterous claims, quantum mechanics suggested that subatomic particles were subject to a certain degree of randomness in their motion. This was very much at odds with Newton's



strict determinism, but subatomic observations seemed to support the idea. This random wrench in the works made many physicists uneasy.

Although Einstein helped to invent quantum theory, he famously balked at the notion of inherent randomness, insisting that “[God] does not play dice.” He and other subscribers of old-fashioned determinism were convinced that subatomic scraps of matter do not move randomly; rather, they are merely unpredictable. Some “hidden variables” must account for the apparent randomness.

Just as humans were once unaware of jet streams' influence on the Earth's weather, unseen mysterious systems could govern the subatomic. It was Einstein's opinion that quantum theory would never be complete unless it discovered and accounted for these variables.

This still-unsettled argument, as esoteric as it may seem, has grand implications in our reality. If there is true randomness in nature, then the physical world is built upon squirrelly stuff indeed. This would mean that our universe is—at least in part—the product of haphazard subatomic particles, devoid of purpose.

If, however, there is no such thing as true randomness, then all matter and energy everywhere *must* follow a single, unwavering path through space and time under the dominion of inertia, gravitation, friction, nuclear forces, and so on. Furthermore, if it were possible to observe every particle in the universe at once and one had a complete knowledge of the forces of nature, the future would not be a mystery—it would be predictable with 100 percent accuracy.



Likewise one could “calculate” any moment in the past with perfect precision. In this paradigm, every object that ever existed—stars, planets, puppies, and brown paper packages tied up with string—was inevitable, and the universe could not have unfolded differently. Our brains—and the squirts of electrons we call “thoughts”—would be no exception. Without randomness at some level, then “choice” is laughable and “free will” an illusion.

If Einstein was right, then this book is the inevitable consequence of the universe. If he was wrong, then this unlikely collection of fascinating facts is the product of random rutabaga snorkel vibraphone.

ALIEN HAND SYNDROME



ALIEN HAND SYNDROME

A bizarre medical condition gives control of an arm to unknown forces

In 1908, the German neurologist and psychiatrist Dr. Kurt Goldstein was bewildered by the strange behaviors manifest in one of his patients. The 57-year-old woman reported that her left hand had a "will of its own," and indeed it seemed to possess its own sinister agenda. The rogue limb moved around involuntarily and its searching fingers tended to fiddle with the various objects they chanced upon. If she didn't keep an eye on her arm, she couldn't quite be sure what it was up to. More alarmingly, her conjoined tormentor occasionally wrapped its fingers tightly around her throat, forcing her to defend herself with her more obedient arm. Dr. Goldstein was at a loss for how to treat his patient's unsettling abnormality.

Although Goldstein was the first to record the phenomenon officially, his patient wasn't the first to be afflicted with this rare and astonishing malady, nor would she be the last. It was not until 1972, however, that it was recognized officially as a legitimate disease.

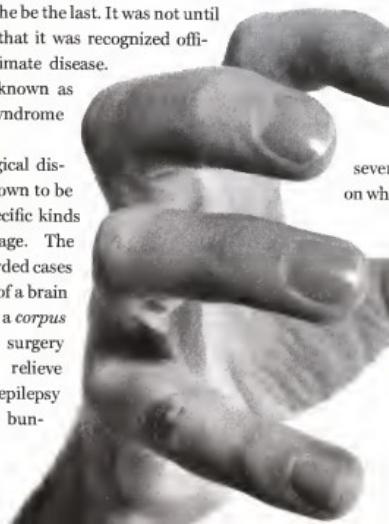
It came to be known as Alien Hand Syndrome (AHS).

This neurological disorder is now known to be the result of specific kinds of brain damage. The majority of recorded cases are a side effect of a brain operation called a *corpus callosotomy*; a surgery that helps to relieve extreme cases of epilepsy by severing the bun-

dle of nerve fibers that carry information between the two hemispheres of the brain. On occasion, a hand can also become alienated because of head trauma, stroke, aneurysm, tumor, or certain degenerative brain conditions such as Alzheimer's disease and Creutzfeldt-Jakob disease.

The specific symptoms and severity of Alien Hand Syndrome depend on which sectors of the brain have been compromised. Although patients typically retain sensation in the alien hand, they feel strongly

■ Certain brain injuries can cause one's hand to develop its own menacing agenda.



that the rebel limb does not belong to them. They will often dissociate themselves from the hand by personifying it—sometimes assigning it a name—and attribute its inexplicable movements to ghosts or gods. Some sufferers experience only a few isolated episodes, but in most cases the alien arm is active whenever its owner is conscious.

One AHS sufferer was unable to smoke because her rogue hand would pluck the cigarette from her lips and toss it away before she could light it, leading the woman to surmise that "he" didn't want her to smoke just then.

The mildest form of the syndrome is caused by damage to the brain's parietal and/or occipital lobe, causing a hand to unconsciously avoid contact with objects by "levitating" with its fingers extended. When damage occurs to the corpus callosum—the data link between the brain's two hemispheres—the nondominant hand can develop what seems to be an independent sense of purpose, groping around its environment and manipulating the objects it finds. Sometimes the sufferer is completely unaware of what the hand is doing until it is brought to his attention or until he happens to notice the shenanigans.

Alien hands have been implicated in a variety of misdeeds, such as unbuttoning the sufferer's own shirt, adjusting a thermostat, or involuntarily stuffing food in the mouth. In some cases it will grasp onto an object and hold on stubbornly, requiring the patient to peel back the fingers in order to let go. Such incorrigible behavior prompts many AHS sufferers to speak to the unruly arm in an attempt to reason with it, some becoming so frustrated

that they try to modify its behavior through punishment. Others simply use their obedient hand to restrain the strangeness.

In a report published in the *Journal of Neurology, Neurosurgery, and Psychiatry*, Dr. Ramón Leiguarda and his colleagues recorded several firsthand accounts from AHS sufferers. A 65-year-old man reported the following:

“While I was traveling on a bus I noticed that a hand was approaching me on the right from behind, trying to catch me. After grasping my trouser leg, the hand did not release it. First, I thought somebody was assaulting me, but then I realized that it was my own right hand, although I did not feel it belonged to me. Thereafter, the fingers developed creeping movements, and repetitive jerks involving the whole arm soon followed. I was unable to control my right hand and I had to grasp and hold it with my left hand. My right arm felt heavy and awkward. I was very anguished, anxious, and frightened, and had palpitations.”

The researchers also recounted the experience of a 50-year-old woman who developed AHS following a brain hematoma:

“Suddenly I had a strange feeling on my left side; later I could not recognize the left arm as my own; I felt it belonged to someone else and wanted to hurt me because it moved towards me; I saw it quite big and distorted like a monster; I was terrified.”

When the arm approached the woman's face during a session with one of the authors, she begged for him to stop the “monster,” pleading, “Look, it's coming . . . please help me.” A quick injection of Valium put her at ease.

One particularly unorthodox subtype of Alien Hand Syndrome can arise due to lesions on the corpus callosum, producing a phenomenon called *intermanual conflict*. For these frustrated few, the

alien hand constantly meddles in the affairs of the obedient hand. For instance, one particular patient had difficulty operating a TV remote because the wayward hand would snatch it away as soon as he picked it up with his good hand. In another case, a woman experienced difficulty getting dressed because the alien hand would unhook the buttons on her blouse immediately after she buttoned them. Yet another AHS sufferer was unable to smoke because her rogue hand would pluck the cigarette from her lips and toss it away before she could light it, leading the woman to surmise that "he" didn't want her to smoke just then.



Although the alien hand's actions are seldom threatening, there are a few recorded cases where the dissident limb seems to wish harm upon its host body. Alien hands have been known to grab and tear owner's clothes, attempt to strangle the sufferer, punch the patient in the face, or grab a steering wheel and turn the vehicle unpredictably. The out-of-control hand can also be a source of profound embarrassment, such as the case of a right-handed man who developed AHS in the aftermath of a stroke. His left hand

■ *Occasionally alien hands attempt to strangle their owners.*

MOVING BEYOND THE FIVE SENSES

Our basic childhood education equips us to name our five senses: sight, hearing, touch, taste, and smell. However, many neurologists will offer a greater number, sometimes citing nine senses up to as many as 21. These other senses are often subdivisions of the five major ones. For example, the perceptions of pressure, heat, and pain belong to the category of touch. The lesser-discussed interoceptive senses include the crucial proprioception, the brain's knowledge of the relative positions of the body's parts. Like any of our senses, though, this ability can fail.

The loss of this sense is known as Proprioception Deficit Disorder, Sack's Syndrome, or Descartes' Disease. This rare disorder shows early symptoms in the form of vivid dreams of lost motor function. Soon the patient suffers a "disembodied" feeling as though the mind and body have completely separated. Simple daily tasks like opening a door or holding a shopping bag become a string of carefully executed steps performed to control one's own body like a puppet.

Neither contagious nor genetic, the cause of permanent Proprioception Deficit Disorder is unknown, though a temporary form can be triggered by massive overdoses of vitamin B₆. Some statistics suggest greater education correlates to greater risk for the disorder, indicating that the ailment may be psychophysiological.

would involuntarily grasp at objects and cause considerable mischief, and on occasion it would unfasten its owner's trousers and "gratify" him without regard for his surroundings. Needless to say, the stroke victim was dismayed when he discovered the hand doing so in public.

The nature of the brain malfunction that leads to Alien Hand Syndrome is not yet known to science. Movement of the arm and hand are normally driven by a combination of signals from several regions of the brain: The parietal lobe provides the body's position in space, the temporal lobe provides data about past motion strategies, and so on. All of this information is then processed by the frontal lobe into a specific plan of action and the instructions are relayed to the brain's motor strip for execution.

Evidence suggests that the brain's dominant hemisphere—the half that controls an individual's dominant hand—maintains some indirect control over the subordinate hand in carrying out motion; so when the corpus callosum is damaged, the

hemispheres' data link is lost and the subordinate hand is deprived of guidance. Doctors conducting fMRI scans of Alien Hand Syndrome patients found that the liberated limbs seem to be driven by the motor strip directly, neither receiving orders from the frontal lobe nor sending a signal to inform the host that the movement is occurring. The actual source of these motor strip signals remains a mystery.

Since its discovery in 1908, only 50 or so cases of Alien Hand Syndrome have been confirmed. It is believed, however, that many other instances have gone undiagnosed, written off as part of some other psychiatric disorder.

There is no known treatment to restore control over the estranged limbs; however, some patients gradually reacquire voluntary use of the arm as the brain mends its delicate pathways. For the others, the disease can be disarmed for a time by satisfying its primitive tactile urges and giving the fidgety fingers an object to grasp and grope.

THE AMBER TIDE

When a colossal brewing vat ruptures, more than a million pounds of beer are let loose on an unsuspecting city

In the late 1700s, the Industrial Revolution brought about considerable advances in agriculture, manufacturing, and transportation throughout Europe. Steam-powered contraptions paved the way for large-scale production—and large-scale disasters in many industries. The business of beer-making was no exception. The availability of new technologies, coupled with the spirit of competition, led to a brisk battle of one-upsmanship among Britain's beer barons. Over a span of a few decades, many of them upgraded from humble kegs to massive vats, and Londoners were all too happy to imbibe the abundant brew.

Meux's Horse Shoe Brewery on Tottenham Court Road was home to a colossal brewing vat, one of the largest London had ever seen. It was 22 feet tall and 60 feet wide, so voluminous that its owners supposedly celebrated its completion by hosting 200 dinner guests within the titanic beer tank. Afterward it was promptly put into service fermenting 135,000 gallons of beer alongside the brewery's collection of not-quite-as-massive vats. Little did its owners know, however, that this new ale reservoir had been constructed with a regrettable imperfection.

Sometime during the day on October 17, 1814, one of the 29 metal belts that supported the tank separated, presumably due to a defect. The other 28 support straps lacked the strength to maintain the tank's integrity on their own, so they each snapped in quick succession. The monstrous vessel finally ruptured, loosing more than a million pounds of beer. The liberated liquid crashed into the brewery's other vats and smashed them to pieces, adding their contents to the surge of frothy

brew. The building's brickwork walls gave way, and Meux's Horse Shoe Brewery vomited hundreds of thousands of gallons of ale out onto the unsuspecting city.

Those unable to find proper containers used their cupped hands to lap up the tepid pools of dirty beer, or simply drank it directly off the road.

Directly in the path of this flash flood of beer was an area known as St. Giles, a densely populated low-income parish. The massive amber river caused pandemonium in the streets, knocking some buildings from their foundations and totally demolishing others. Men, women, and children were buried in the rubble. Surprised Londoners were whisked off their feet by the fast-moving wall of beer, many of them becoming injured when they were dashed upon

walls. Beer barged into buildings, drowning several people in their own homes and flooding basements.

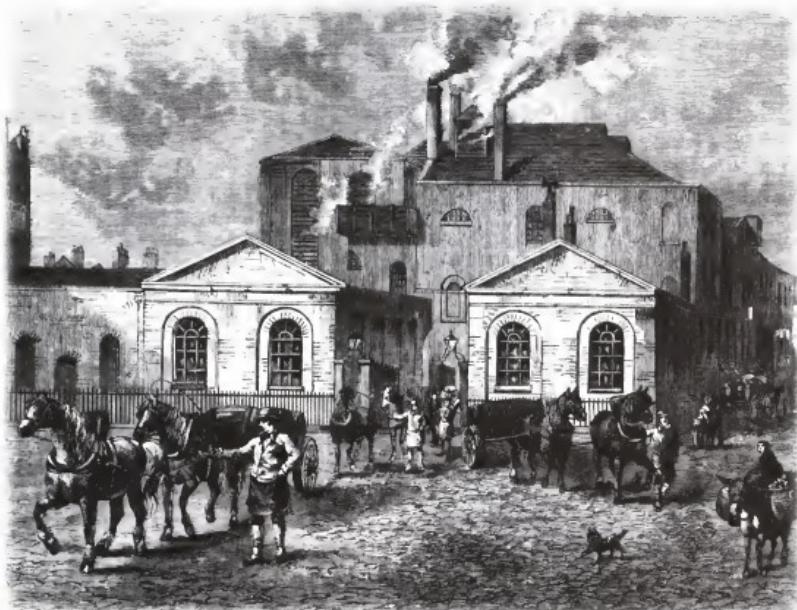
As the foamy wave finally settled, the uninjured bystanders gathered their wits and sprang into action. With cups, pots, cans, and kettles, the people of London rushed to the scene to save as much of the beer as possible. Those unable to find proper containers used their cupped hands to lap up the tepid pools of dirty beer, or simply drank it directly off the road. The streets became so clogged with enthusiastic beer connoisseurs that organized rescue efforts were severely hampered.

After several hours, the stranded were plucked from the rubble and the beer-soaked victims taken to the hospital. There, the unmistakable smell of ale permeated the building, convincing some of

the other patients that they were missing out on a beer party elsewhere in the hospital. The surlier patients participated in a violent protest of this unfair treatment, leading to a few additional injuries.

In all, nine people were killed by the drink that day due to "drowning, injury, poisoning by the porter fumes, or drunkenness." Their coffins were lined up in a yard, where passersby could leave coins to help pay for the funerals.

It took weeks for the smell of beer to completely fade from St. Giles. Meux's Horse Shoe Brewery was eventually brought to court over the devastating calamity, but the judge and jury ultimately blamed no one. The tsunami of beer, they concluded, was simply an "Act of God."



After the flood: A cleaned and repaired Meux's Horse Shoe Brewery is captured in an 1830 engraving.

AN AMERICAN COUP D'ÉTAT

A well-funded league of fascist conspirators attempt to overthrow the U.S. government

In the early 1930s, some of the world's most prosperous men assembled for a secret meeting in New York City. Allegedly, the first and only item on the agenda was to discuss the dissolution of America's democracy. The country was in the grip of the Great Depression, and the well-off were growing weary of watching as their fortunes deflated and their investments evaporated. As men of action, the resourceful New York group sought to eliminate what they reasoned to be the crux of the catastrophe: the United States government.

The New York conspirators had secured the support of 500,000 Great War veterans, and it was their earnest hope that this army could overpower the feeble peacetime U.S. military and reconstitute the government as a more economical fascist dictatorship. But in order to bring their diabolical scheme to fruition, the plotters required the assistance of Smedley Darlington Butler, a former major general of the U.S. Marine Corps.

General Butler's long military career was packed with conspicuous gallantry, making him a well-known war hero among the soldiers and citizens of the U.S. During his service he was awarded the Distinguished Service Medal of both the Army and the Navy; he was one of only 20 people in history to receive the Marine Corps Brevet Medal; and he was one of only a handful of men to twice receive the Medal of Honor. Despite his intrepid leadership in multiple conflicts, Smedley "the Fighting Quaker" Butler gradually developed some resentment toward the U.S. government for its tendency to use the military for corporate interests.

In July 1930, when the Commandant of the Marine Corps Wendell C. Neville died unexpectedly, it was widely assumed that the responsibility would pass to the most senior major general on the active list, General Butler. But his candid comments regarding military misapplication had won him many political enemies, including President Hoover, so the nomination was given to one of the other generals instead. The following year General Butler was threatened with a court-martial after he recounted some gossip about Italian dictator Benito Mussolini running over a child in his car. Butler voluntarily retired from active duty soon thereafter.

About six months later, a sea of exasperated World War I veterans surrounded Capitol Hill in Washington, D.C. The mass of over 20,000 unemployed former soldiers had set up an encampment there to urge the early payout of their Service Certificates, a pension that had been granted to them in 1924 but was not scheduled to be paid for another 13 years. General Smedley Butler—known as "Old Gimlet Eye" to many of the vet-

erans—addressed the marchers amidst a storm of applause, describing the event as “the greatest demonstration of Americanism we've ever had.” Three days later, two cavalry regiments descended upon the veterans’ encampment. Calamity ensued. Brandishing rifles, bayonets, and tear gas, the soldiers scattered the so-called Bonus Army and set their shanty town ablaze.

The incident, combined with the economic breakdown it represented, led many citizens to suspect that the liberal democracy of America was hopelessly broken. Revolutionary rumblings were afoot, and some of the nation’s wealthiest men began to seriously contemplate taking matters into their own hands. Such sentiments were cemented when Franklin Delano Roosevelt was elected and began to execute his New Deal, a series of reforms that decoupled American currency from the gold standard and erected a tall stack of corporate regulations. Convinced that the program would produce cataclysmic economic effects, the cabal of capitalist conspirators allegedly set their plan into motion.

■ Above: Upstanding patriot General Smedley D. Butler. At right: Gerald MacGuire of the ironically named American Liberty League.



On July 1, 1933, Smedley Butler was visited by a pair of gentlemen who urged him to run for the office of National Commander of the American Legion, an influential organization of veterans. Though Butler declined the invitation, one of the men—Gerald

MacGuire—made several subsequent visits during which he disclosed additional details. He claimed to represent the Committee for a Sound Dollar, whose primary purpose was to pressure the President to reinstate the gold standard. He implied that his organization had the support of several important political leaders, and that it was bankrolled by some of the country’s most affluent individuals and successful corporations.

The credibility of MacGuire’s claims was reinforced when he produced evidence of considerable cash resources and made some eerily accurate predictions regarding personnel changes in the White House. He also foretold the formation of the American Liberty League, a high-profile group whose stated purpose was to “defend and uphold the Constitution.” The League’s principal players were comprised of wealthy Americans, including the leaders of DuPont, JP Morgan, U.S. Steel, General Motors, Standard Oil, Colgate, Heinz Foods, Chase National Bank, and Goodyear Tire. There are some who claim that

Prescott Bush—director of one of the world’s largest shipping companies and father to the 41st U.S. President—was also entangled in the scheme.

On August 22, 1934, Gerald MacGuire dropped all pretenses when he met with General Butler at an empty hotel restaurant. He indicated that his financial backers aimed to assemble an army of half a million disgruntled veterans, including the remains of the original Bonus Army. He also stated that the group would like Butler to be the leader of this force. “We’ve got three million [dollars] to start with on the line,” MacGuire claimed, “and we can get three hundred million if we need it.”

According to MacGuire, the League's members could easily manipulate the media to provide public approval. He explained the League's intent to mimic the methods of Benito Mussolini, the Italian dictator who had risen to power a decade earlier with the support of a similar veteran militia. Mussolini's coup d'état had successfully restored Italy's industrial viability, so it seemed the ideal model for repairing America's impoverished economy. Roosevelt and other existing U.S. leadership would be allowed to remain as figureheads, MacGuire explained, while the true policy-making power would fall to a new cabinet position that Smedley Butler would occupy: the Secretary for General Affairs.

Revolutionary rumblings were afoot, and some of the nation's wealthiest men began to seriously contemplate taking matters into their own hands.

"Old Gimlet Eye" Butler indicated some interest in the arrangement and invited an associate named Paul Comly French to join the discussions. "Roosevelt hasn't got the real solution to the unemployment situation," MacGuire allegedly told French, "but we'll put across a plan that will be really effective. All unemployed men would be put in military barracks, under forced labor, as Hitler does, and that would soon solve that problem. Another thing we would do immediately would be to register all persons in the United States, as they do in Europe. That would stop a lot of Communist agitators wandering around loose." He also hinted that weapons would be furnished by the Remington Arms company, in which the Du Pont family owned a controlling interest.

The American Liberty League's strategy seemed bold, but not implausible. At that time much of the public held the president in low regard, and the League members had considerable control over the

nation's news outlets. Furthermore, the U.S. armed forces were at decreased peacetime levels. With the Fighting Quaker to galvanize the 500,000 armed revolutionaries, it was possible that such a coup could be successful.

In the autumn of 1934, General Butler finally sprang into action. A crowd of journalists surrounded him as he addressed the nation in a press conference. But the General—known as "Old Duckboard" to many Americans—did not demand the surrender of the United States government. Instead, he related to the reporters the details of the secret pro-fascist plot and described the principal players. "The upshot of the whole thing," he explained, "was that I was supposed to lead an organization of 500,000 men which would be able to take over the functions of government." The Old Gimlet Eye, it turned out, had been playing along with Gerald MacGuire to glean information about the plot. Though Smedley Butler had indeed grown weary of being a government-sponsored "gangster for capitalism," he was still a true patriot. Butler's associate—Paul Comly French—was in actuality an undercover reporter for the *Philadelphia Record* and *New York Evening Post*. The two men testified before the House Un-American Activities Committee (HUAC), delighted to disclose all they had gathered from MacGuire. The committee additionally heard testimony from James Van Zandt, the National Commander of Veterans of Foreign Wars, who stated that he had also been approached to lead such a march on Washington.

MacGuire and the wealthy men he allegedly represented all denied involvement in any such plot, referring to such suggestions as "a joke, a publicity stunt." They even publicly questioned the sanity of General Butler. But MacGuire couldn't keep his story straight, often contradicting his previous testimony, which was crippling to his credibility.

Ultimately the investigative HUAC concluded that there was indeed compelling evidence of a plot, reporting that "In the last few weeks of the

Committee's official life it received evidence showing that certain persons had made an attempt to establish a fascist organization in this country . . . There is no question but that these attempts were discussed, were planned, and might have been placed in execution when and if the financial backers deemed it expedient."

The press was quick to pick up the story, referring to the conspiracy as a "plot without plotters," which "failed to emerge in any alarming proportion." A handful of papers took the story seriously, but most newsmen ridiculed the notion that their bosses' close acquaintances would participate in such rabble-rousing.

The government's inaction was also swift and decisive. Criminal charges were brought against no one, and the collection of prominent men implicated in the plot were immediately excused from testifying; in fact, all mention of their names was scrubbed from the committee's public report. The omitted bits of the report were published by John L. Spivak in January 1935, after he was mistakenly furnished with an uncensored transcript of the hearings, but the press and the public accepted the additional information with indifference.

Theories regarding the government's apparent apathy are plentiful. Foremost is the fact that there were still relatively few laws to address such conspiracies during peacetime, so it was unclear what charges could be made with so little evidence. In addition, the plot was replete with political figures and the social elite, turning any journey toward justice into a minefield for all involved. Moreover, one month after the report was issued, Gerald MacGuire died of "natural causes" at the age of 37, eliminating the only witness with insight into the shadowy cabal.

Smedley Darlington Butler continued to speak and write regarding what he referred to as the "racket of war." In an oft-quoted article from a 1935 issue of the socialist magazine *Common Sense*, Butler said:

"I helped make Mexico and especially Tampico safe for American oil interests in 1914. I helped make Haiti and Cuba a decent place for the National City Bank boys to collect revenues in. I helped in the raping of half a dozen Central American republics for the benefit of Wall Street. The record of racketeering is long. I helped purify Nicaragua for the international banking house of Brown Brothers in 1909-12. I brought light to the Dominican Republic for American sugar interests in 1916. I helped make Honduras 'right' for American fruit companies in 1903. In China in 1927 I helped see to it that Standard Oil went its way unmolested . . . Looking back on it, I felt I might have given Al Capone a few hints. The best he could do was to operate his racket in three city districts. We Marines operated on three continents."⁹⁹

In the same year he wrote the short book *War Is a Racket* wherein he advocated the transition of the military into a powerful defense-only force. His dream was to eliminate military gangsterism by restricting the American Navy to within 200 miles of the U.S. coast, to limit armed aircraft to within 500 miles, and to prohibit the army from even setting foot off of the U.S. mainland.

In the decades since the Business Plot was brought to light, many historians have suggested that the treachery was exaggerated by Butler, or that Gerald MacGuire overstated the resources at the conspirators' disposal. There is much evidence, however, to suggest that not only was such a fascist-friendly conspiracy afoot but that its underwriters had the will—and very nearly had the resources—to bring their un-American ideas to fruition. Were it not for the uncompromising patriotism of Retired Major General Smedley Old Gimlet Eye Duckboard Fighting Quaker Butler, the outcome of that turbulent time might have been profoundly different indeed.

AMOEBOIC ALTRUISM

When food supplies run out amoebas join together to form complex organisms—and teach us something about the meaning of life



Food had once been plentiful for the amoeba colony, but no longer. Their home—a scrap of deer dung that once provided all their needs—has become a trap from which they must escape. In the early days, the amoebas had feasted on a rich supply of bacteria, but as the generations passed and the population swelled, they had exhausted their food supply. Now starvation threatens. As desperation sets in, one amoeba sends out a cry for help.

The starving amoeba emits a chemical signal in the form of cyclic adenosine monophosphate, or cAMP. Nearby amoebas respond by sprouting tentacle-like pseudopods and shuffling toward their distressed comrade. They also start to ooze cAMP themselves, amplifying the call until the signal spreads to the far reaches of the colony. The amo-

bas come together and pile on top of one another in growing numbers until the group becomes visible to the naked eye.

At first their behavior might seem odd; to gather together in the face of starvation surely ought to end in cannibalism or death. Not so, for they are capable of an extraordinary transformation. The amoebas



■ An electron micrograph reveals the beginnings of two spore towers.

set aside their lives as individuals and join ranks to form a new multicellular entity. These astonishing creatures are *Dictyostelium discoideum*, and they are a member of the slime mold family (also known as "social amoebas").

Up to 100,000 of the amoebas assemble in response to the cAMP distress call. They first form a tower, which eventually topples over into an oblong blob about two millimeters long. The virtually identical amoebas within this pseudoplasmodium, then begin to differentiate and take on specialized roles inside the compound organism which resembles a small slug.

The "slug" begins to seek out light, leaving behind a slimy trail. Some of the amoebas become "sentinels," taking on immunelike functions. They circulate through the slug as a patrolling protozoal police force, hunting for invading pathogens. If they find any, they will engulf the invader and prevent it from proceeding. These sentinels are periodically sloughed off—along with any pathogens they have swallowed—and abandoned in the trail of slime.

Once the slug finds a suitably sunny location, the unlucky cells at the "head" of the slug form a stalk for the others to climb. These stalk cells—which make up roughly a fifth of the total population—will sacrifice themselves to provide a path up for their comrades. The remaining cells climb the stalk and jostle together on its tip. This results in the formation of a "fruiting body," a structure that resembles a lemon balanced on top of a floppy wire. The amoebas then form spores, which are carried away by the wind, passing animals, or insects. After touching down in a suitable location, the amoebas emerge from spore form and begin the cycle anew, once again acting as independent individuals.

This process and the impressive displays of self-sacrifice make sense, so long as all the amoebas that make up the slug are genetically related. Though individuals perish in the act of engulfing

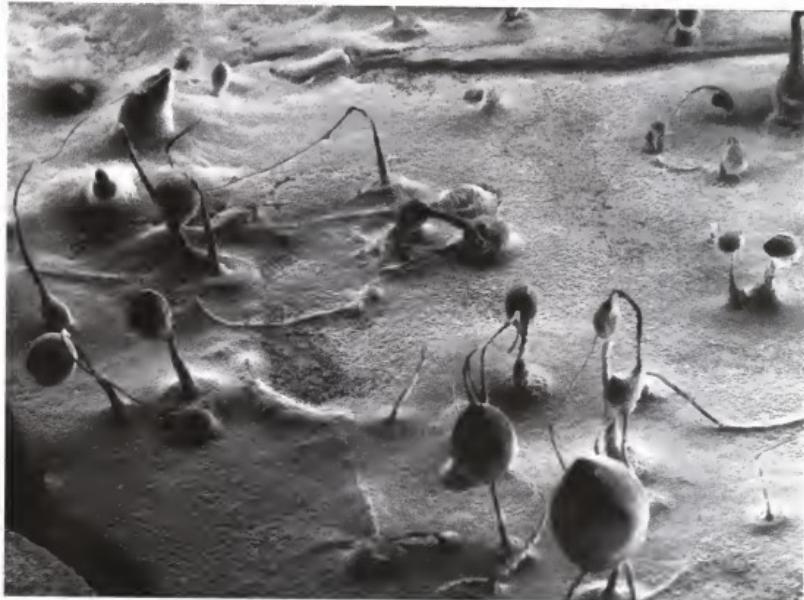
pathogens and producing the stalk, they pass along their genetic legacy via their kin. The genetic situation is somewhat different for slime molds. When the cAMP call goes out, not only related amoebas respond: Amoebas

of many differing strains can come together to form a single slug. Presumably, if individuals of one strain could figure out a way to duck out of stalk and sentinel duty, they would be expected to reproduce faster than their nobler compatriots. As is true with all organisms, some individual amoebas will take advantage of the colony's resources without contributing anything back. In theory, such "scroungers" could potentially have a survival and reproductive advantage, thereby undermining the cooperative lifestyle. Such cheating does take place, but *D. discoideum* possesses some effective mechanisms for keeping it in check.

For one thing, the amoebas prefer to unite with kin. Under ordinary circumstances amoebas reproduce via division, surrounding themselves with identical copies; so much so that it is rare for these amoebas to run across a nonrelative. Each amoeba can recognize its clones through molecular markers, and they only mingle with other strains if the population is low. At such times, the ability to form a larger slug outweighs the risk of snuggling up to strangers.

Evidence also suggests that some social amoebas have evolved to link reproductive genes with altruistic ones. In the case of *D. discoideum*, researchers created a mutant strain of cells that were "deaf" to the chemical signal to become a self-sacrificing stalk

The traits of self-sacrifice and reproduction had become genetically entangled, it seems, allowing only the altruistic amoebas to produce offspring.



■ Fruiting bodies prepare to disperse legions of spores out into the world.

cell. They then watched to see if these cells would gain a reproductive advantage. Just the opposite took place. The "cheater" mutant cells did not join in stalk formation, yet they rarely made it up the stalk to become spores, and therefore they died out. The traits of self-sacrifice and reproduction had become genetically entangled, it seems, allowing only the altruistic amoebas to produce offspring.

The study of *D. discoideum* is also shedding light on how cells communicate. *D. discoideum* uses many of the same signaling processes found in all multicellular creatures. But unlike fish or frogs, *D. discoideum* can be frozen, thawed, grown by the millions in a matter of days, and stored away for years if need be. Due to the cells' ability to operate independently as well as in groups, the social

amoeba has been credited with an impressive list of scientific breakthroughs regarding the functions of proteins, methods of cell communication, etc.

These amoebas' tendency to act in the common good might inspire admiration in many. Yet a more cynical observer might point out that the amoebas are moved not by love or moral scruples, but by the cold mechanics of natural selection. Amoebas behave altruistically only because natural selection has led to a stable state in which self-sacrifice is the best way for them to pass on their genes. But the end result is the same, regardless of the natural forces that have shaped it. Altruism triumphs, and through their mutual selflessness the adaptable amoebas arrive at a new patch of bacteria-laden dung to call home.

ANIMAL WEAPONRY

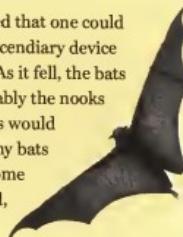
The other kind of biological warfare

Through most of human history, one of the obvious shortcomings of weapons was that once a missile was launched, all one could do was watch. Slings, arrows, catapults, cannons, and insults all suffered for the inability to alter their course after firing. In the era before GPS and radar guidance, however, some clever people tried to meld their weapons with things that could steer themselves: animals.



HOMING PIGEON BOMB *Project Pigeon* was an attempt to make a guided bomb during World War II. American behaviorist B. F. Skinner had some success training pigeons to peck at a target on a small screen. Housed in a compartment within the bomb, pecks on the middle of the screen would indicate the target was dead ahead, and pecks at the edge would tell the bomb to tilt to change the angle of descent. The U.S. government only granted him \$25,000 for research, however, before they decided to alter course.

BAT BOMBS Also during the Second World War, Lytle S. Adams theorized that one could put a large quantity of bats into a state of hibernation, strap a small incendiary device to each one, then drop them over a city in a specially designed bomb. As it fell, the bats would be released, and hopefully seek out a dark place to rest—preferably the nooks and crannies of buildings. A few minutes later the bomb-strapped bats would explode, touching off fires throughout the city. During initial tests many bats died because they failed to wake up before hitting the ground. After some accidentally released bats set fire to an auxiliary army base in Carlsbad, New Mexico, the \$2-million project was dropped.



CHICKEN BOMB Early in the Cold War, Britain feared that the USSR might decide to use its massive military to take over Europe. The Russians had a wealth of conventional weaponry, so something drastic would be needed to stop them. To that end, the Brits designed a large nuclear land mine with a ten-kiloton yield and intended to pepper them throughout Germany in case the Soviets came traipsing through. There was a risk that such mines would be rendered inoperative due to winter cold, so one variation of the bomb design called for live chickens to be housed inside the bomb in hopes that the poultry body heat would keep the delicate switches, electronics, and explosives at operating temperatures. On the eve of production, however, someone decided that laying nuclear land mines in allied countries was an ill-advised notion.



BEE STINGS In 1994, scientists at the Wright Laboratory, a predecessor to today's United States Air Force Research Laboratory, contemplated a weapon that would aerosolize and disperse the pheromones of bees onto enemy troops. A number of hives would be scattered about the battlefield in anticipation of the enemy's arrival. The idea was that the amorous bees would then seek out the men tainted with the natural attractant and sting them into submission.

RAT CARCASS EXPLOSIVES During World War II, the British Special Operations Executive (SOE) developed a fondness for moving spy equipment in and out of enemy territory within ordinary-looking objects. SOE operatives hid secret instructions inside toothpaste tubes, concealed hand grenades inside hollowed logs, and smuggled microfilm inside champagne corks. One of their shrewder designs involved rat carcasses which had been gutted and refilled with tiny explosives. Planners intended to plant these retrofitted rats into German coal shipments in the hopes that they would end up inside Nazi boilers, resulting in considerable destruction. Unfortunately a shipment of these rat bombs was intercepted by German forces before the plan could be brought to fruition, increasing Nazi vigilance, and spoiling the surprise.

BACTERIOLOGICAL APOCALYPSE

How a humble bacteria nearly wiped out all life on Earth

About two and a half billion years ago, life on Earth was still in its infancy. Complex organisms such as plants and animals had not yet appeared, but the planet was teeming with microscopic bacteria that thrived in the temperate and nutrient-rich environment. Greenhouse methane lingered in the atmosphere and trapped the sun's warmth, creating a very accommodating climate for the stew of microbes that made their home on primitive Earth.

Some time in prehistory, however, a billion years of bacterial evolutionary progress was suddenly stunted by a catastrophic global event. Geologists see no evidence of a great meteor impact or a volcanic eruption corresponding to the event, but they have uncovered the unmistakable geologic scars of rapid worldwide climate change. Average temperatures, which were previously comparable to our present climate, plummeted to minus 50 degrees Celsius and brought the planet into its first major ice age. This environmental shift triggered a massive die-off that very nearly extinguished all life on Earth. Paleoclimatologists have good reason to believe that event was unwittingly caused by some of the planet's own humble residents: bacteria.

The period in history is known as the Paleoproterozoic era, a time when the ocean was tinted green with iron, and the atmosphere was dominated by gases other than oxygen. The sea was host to a plethora of microorganisms, including a few members of a newly evolved variety: a blue-green algae known as cyanobacteria. These adapted

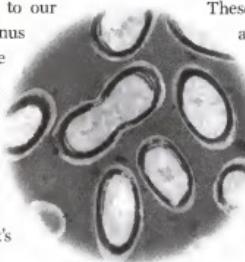
bacteria were the first to use water and sunlight for photosynthesis, producing oxygen as a by-product of their metabolism.

The cyanobacteria were a struggling minority at first, but scientists believe that these new microbes began to dominate with the help of meltwater from a few glaciers scattered over the young continents.

These glaciers spent centuries scraping across the Earth collecting minerals, ultimately depositing their rich nutrient payloads into the oceans.

The cyanobacteria flourished in the presence of the increased minerals, and the rapidly growing population was soon venting increasingly large amounts of corrosive oxygen into the environment.

At first the damage was limited to the oceans' ecosystems. The oxygen began to chemically react with the abundant oceanic iron, eventually scrubbing the seas clean of the element



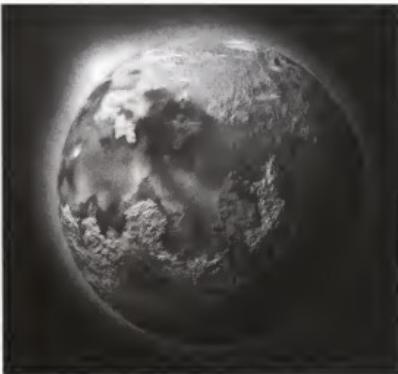
■ Cyanobacteria first emerged 1,600 to 2,500 million years ago and were the first life form to use photosynthesis to metabolize food.

through oxidation. The oxidized iron settled to the ocean floor, and the oceans' green tint began to fade. This series of developments was nothing short of an ecological disaster—oxygen was poisonous to most of primitive Earth's inhabitants, and many bacteria relied on the iron as an essential nutrient.

With very little competition for resources, cyanobacteria continued to proliferate and pollute. The free oxygen they produced began to seep from the sea into the air, gradually breaking down the methane that kept the Earth's atmosphere warm and accommodating. It took at least a 100,000 years, a short duration in geological terms, but the Earth was eventually stripped of her methane and with it her ability to store the heat from the sun. Temperatures fell well below freezing worldwide, and a thick layer of ice began to encase the oxygen-saturated planet.

Not even cyanobacteria were immune to the effects of this major ice age. The traits that had once given them such an evolutionary advantage had now created an environment that was completely inhospitable. As the centuries marched on, the surface became increasingly cold and frozen, with the ice at the equator eventually reaching up to one mile in thickness. Earth was an ice planet. Thermal vents on the ocean floor provided pockets where some resilient bacteria managed to survive, and certain organisms that lived underground were insulated from much of the destruction, but these reservoirs of life were scarce. Almost every living thing on Earth died as a result of this massive event known as the oxygen catastrophe.

The survivors of the oxygen catastrophe eventually adapted to consume the abundant oxygen and produce carbon dioxide. This greenhouse gas very gradually made its way into the atmosphere, increasing in concentration and nudging temperatures back into the hospitable range over millions of years. Had temperatures been slightly colder during the first major ice age—if Earth had been in a slightly more distant orbit—the planet would have remained an icy wasteland because the carbon dioxide would have frozen solid before it could



■ *The proliferation of cyanobacteria caused a global temperature drop eventually leading to a "snowball Earth."*

promote the greenhouse effect. Before the big thaw began, temperatures had reached as low as minus 50 degrees Celsius, and carbon dioxide freezes into dry ice at minus 78 degrees. Indeed, it seems that life on Earth was spared by a tiny margin.

Today all life on the planet can trace its lineage back to those few microorganisms that survived the great dying of 2,500,000,000 b.c., and now cyanobacteria are among the most common bacteria on Earth. In the billions of years since the first ice age, the environment has been dramatically altered on numerous occasions. Causes have included greenhouse gases that trap heat; shifting tectonic plates that reroute ocean currents; our sun's varying radiation levels; and volcanic activity that alters the atmosphere. But at least once in Earth's long history, its own occupants seem to have unwittingly brought all life to the brink of extinction. The sun is warmer now than it was then, so such a "snowball Earth" is a bit less likely to occur . . . but the cautionary tale cataloged in ancient rocks warns us that the environment is certainly not impervious to the actions of those living in it.

THE BATH SCHOOLHOUSE EXPLOSION

An angry handyman targets a school full of children

In 1924, Andrew Kehoe was elected as the treasurer for the village of Bath, Michigan. He seemed an ideal candidate for the office; his neighbors considered him extremely bright and thrifty, if rather short-tempered. What he didn't divulge was that his wife, Ellen "Nellie" Prince, was suffering from tuberculosis and that her frequent visits to hospital were impoverishing him. While treasurer, Kehoe perpetually bemoaned the high property tax that was financing a new school, and accused superintendent Emory Huyck of gross financial mismanagement. Instead of giving Kehoe a tax break, the school board offered him another recourse: a part-time job as a handyman at the school he so loathed.

His complaints and accusations were the tip of the iceberg; Kehoe had a darker side. Some of his neighbors reported that he was cruel to the animals on his farm and had once beaten a horse to death. None of his neighbors were aware that he'd seen his stepmother catch fire when he was 14 and that he'd waited a while to douse the flames simply because he didn't get along with her. By all appearances, the school board had done the right thing in helping out a financially strapped citizen. They had no way to know it was an overture to one of most horrific mass-murders in U.S. history.

■ *The north wing of the schoolhouse, which housed the second and sixth grades, was destroyed.*



No one is certain when Kehoe began plotting, but he started accumulating dynamite and pyrotol, an inexpensive explosive, in the summer of 1926. He bought only limited quantities at any one time or location so as not to arouse suspicion. When neighbors inquired after the blasts they heard from his property, Kehoe explained that he was removing tree stumps from his land.

Kehoe started his job as the school handyman that winter, and was soon granted full-time, unfettered access to the building. As such, no one questioned his presence in the hallways at any time day or night, and it wasn't unusual to see him hauling materials in and out, working on electrical wiring, or egressing the schoolhouse basement. Unfortunately, despite his new employment, Kehoe was unable to keep up payments on his farm and foreclosure proceedings soon began.

By May 1927 Kehoe was absolutely committed to follow through with his plot. While handing out paychecks to school staff, he made ominous comments to his fellow workers: "You want to take good care of that check as it is probably the last check you will ever get." On May 16, he brought Nellie home from the hospital. Sometime before the 18th, Kehoe filled the backseat of his car with metal objects: shovel blades, broken gears, tools, and rusted junk. He affixed a box of dynamite under the front seat and placed a rifle on the passenger side.

Students arrived at school early on the morning of Monday, May 18, 1927, to finish testing on the last day of the school year. Like most agricultural towns, folks were already well into their workday by 8:45 A.M. When men working in neighboring fields noticed fire and a column of black smoke rising from Andrew Kehoe's property, they called the city, and the volunteer fire brigades began organizing.

On the front gate, a neatly stenciled sign waited for them. It read: "Criminals Are Made, Not Born."

Moments before 9:45 A.M., the north wing of the Bath Consolidated School exploded.

Survivors reported the blast was like a terrible earthquake that tossed the floors of the two-story school building. Flames burst around the foundation, and the north wing—the home of the second and sixth grades—collapsed, killing some of the students and trapping others. The shockwave shook the entire town, prompting the fire brigade en route to the Kehoe place to turn back toward the school.

Rescue efforts began almost immediately. Men and women ran to begin fighting the flames and digging through rubble. Cars were used as ambulances, and a drugstore became a triage center. The town hall served as a makeshift morgue. Local telephone operators quickly got the word out, and help was soon dispatched from nearby Lansing.

About half an hour after the explosion, Andrew Kehoe appeared at the scene. He careened up in his truck and skidded to a halt near the school. Some reports claim that he called out to Superintendent Emory Huyck—the man whom Kehoe blamed for much of the school's cost. All reports agree, however, that Kehoe took the rifle from his seat and with a single shot detonated the cache dynamite stowed in his vehicle. The heap of metal objects atop the bomb were made into shrapnel, which killed Kehoe, Huyck, and three others—including an eight-year-old girl who had escaped the school.

That explosion barely slowed the effort to excavate the school and retrieve the children within. But as rescuers entered the wreckage they found something sinister that halted everything: The basement of the south wing still contained hundreds of pounds of undetonated dynamite and pyrotol.

A team of State Police went in to examine the new threat. They found the explosives wired to an



■ The charred remains of Andrew Kehoe's farmhouse.

alarm clock set to go off at 9:45 A.M. It's not clear whether Kehoe had meant for the north wing to explode first, draw in rescuers, and then kill more people when the other half went, or if the clocks merely got out of sync. Either way, the entire school was doomed to destruction, save for a lucky twist of fate. The first detonation had rattled the wiring in the south wing and caused a short circuit that spared half the building.

Once the recovery effort was well in hand, authorities were again sent out to the Kehoe farm. On the front gate, a neatly stenciled sign waited for them. It read: "Criminals Are Made, Not Born." The house and farm had burned to the ground. Kehoe's livestock had been locked in and were killed in the

fire. It wasn't until the next day that someone found the remains of Nellie Kehoe's body in the charred ruins of the farm. She had been her husband's first victim, killed by a blunt force to the head.

The following week, authorities held an inquest to determine if any of the school's staff had been negligent by failing to detect Kehoe's treachery. In the end they determined that Kehoe had acted alone, held his secrets well, and had done everything possible to evade detection. Three months later, fourth-grader Beatrice Gibbs died after a surgery resulting from injuries she sustained at Bath Consolidated School. She became the 45th and final victim of the deadliest school attack in U.S. history.



BEHEADED AND BEWILDERED

Blink twice if you wish your head was reattached to your neck

For thousands of years, the forceful removal of the human head has been used as a form of capital punishment. In fact, the phrase “capital punishment” was coined specifically to describe execution by decapitation, based on the Latin word *caput*, which means “head.” Since the very beginnings of the practice, there has been much speculation and debate regarding the length of time that the head can remain conscious after its removal. Many argue that a beheaded person will almost instantly lose consciousness due to a massive drop in blood pressure in the brain, and/or the heavy impact of the decapitation device. But there are countless eyewitness reports in history describing a few moments of apparent awareness in the disembodied head.

The suspicion that a severed head remains conscious and able to experience pain has led most governments to discontinue beheading as a method of execution, so there has been no recent scientific observation of human decapitation. However, studies of decapitated animals have lent some credibility to the massive number of stories regarding a head’s brief consciousness after being separated from the body. Under certain circumstances, it is very possible that a suddenly separated head may remain lucid long enough to know its fate.

In many cases the anecdotal evidence describes blinking eyes, wandering gaze, and moving lips on a freshly amputated head. As grotesque and troubling as these movements may be to the witnesses, such muscular spasms are not surprising. It is common for any separated limb to twitch briefly due



◀ This'll only hurt for a moment . . . hopefully.

to reflex nerve action. More difficult to attribute to nerve reflexes are the stories of specific facial expressions sometimes seen on the faces of the beheaded as they died. Some were said to change expressions several times in the last few moments, ranging from pain and confusion to grief and fear.

During the French Revolution—the heyday of the guillotine—it is said that many of the condemned were asked to blink for as long as possible after the blade dropped in an effort to measure post-decapitation awareness. While many reportedly did not blink at all, some complied for as long as 30 seconds. Still other observations describe much more specific reactions to stimuli following beheading. Consider the case of Languille, a convicted murderer who was guillotined in France. He was observed by Dr. Beaureieux during his execution at 5:30 A.M. on June 28, 1905. As written in *Archives d'Anthropologie Criminelle*, here are the doctor's observations:

“Here, then, is what I was able to note immediately after the decapitation: The eyelids and lips of the guillotined man worked in irregularly rhythmic contractions for about five or six seconds . . . I waited for several seconds. The spasmodic movements ceased.

The face relaxed, the lids half closed on the eyeballs, leaving only the white of the conjunctiva visible, exactly as in the dying whom we have occasion to see every day in the exercise of our profession, or as in those just dead.

It was then that I called in a strong, sharp voice: ‘Languille! I saw the eyelids slowly lift up, without any spasmodic contractions . . . Next Languille’s eyes very definitely fixed themselves on mine and the pupils focused themselves . . . After several seconds, the eyelids closed again, slowly and evenly, and the head took on the same appearance as it had had before I called out.

It was at that point that I called out again and, once more, without any spasm, slowly, the eyelids

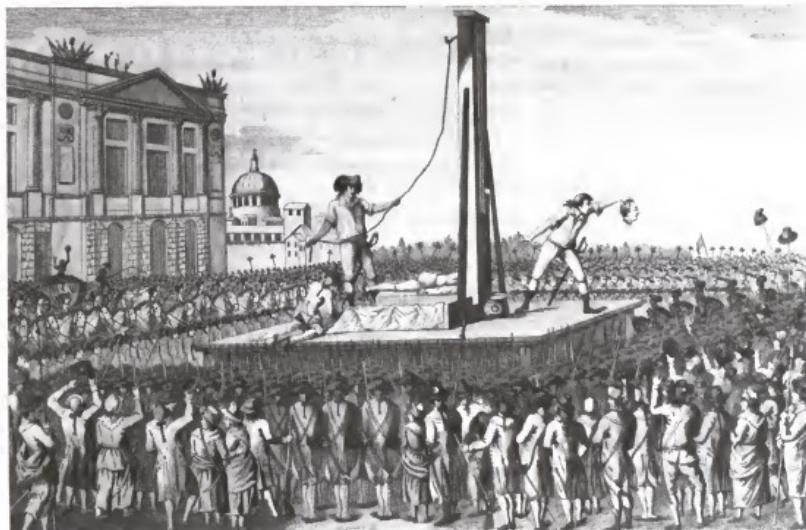
lifted and undeniably living eyes fixed themselves on mine with perhaps even more penetration than the first time. Then there was a further closing of the eyelids, but now less complete. I attempted the effect of a third call; there was no further movement and the eyes took on the glazed look which they have in the dead.

I have just recounted to you with rigorous exactness what I was able to observe. The whole thing had lasted 25 to 30 seconds.”

During the French Revolution—the heyday of the guillotine—it is said that many of the condemned were asked to blink for as long as possible after the blade dropped in an effort to measure post-decapitation awareness.

In the book *Crucibles: The Story of Chemistry*, a story is related where the unnamed servant of chemist Antoine Lavoisier was beheaded by guillotine. According to the writer, Lavoisier immediately picked up the head and asked the servant to blink if he understood. Reportedly, the man blinked. There is also an oft-repeated anecdote involving Antoine Lavoisier's own later experience on the guillotine in 1794. The story is dubious considering that it does not appear in any of his biographies, but reportedly he told his assistant that he would blink for as long as he was able after execution, and successfully did so for 15 to 20 seconds.

A more recent account tells of an accidental decapitation in an automobile. In 1989, a U.S. Army veteran who served in the Korean war was riding in a taxi with a friend when it collided with a truck.



■ In France the guillotine was the official method of execution until the country abolished the death penalty in 1981.

The witness was pinned to his seat, and the friend was decapitated by the collision:

“My friend’s head came to rest face up, and (from my angle) upside-down. As I watched, his mouth opened and closed no less than two times. The facial expressions he displayed were first of shock or confusion, followed by terror or grief. I cannot exaggerate and say that he was looking all around, but he did display ocular movement in that his eyes moved from me, to his body, and back to me. He had direct eye contact with me when his eyes took on a hazy, absent expression . . . and he was dead.”

Not all attempts to observe consciousness in decapitated heads has been successful. In 1836, a murderer named Lacenaire agreed to wink after execution, but he did not do so. Another murderer named Prunier in 1879 also failed to respond to

stimuli. But it is likely that some individuals will lose consciousness immediately upon decapitation, while others might experience a few horrifying moments of lucidity as their head parts ways with the rest of their person. It is also very possible that most beheaded persons are too disoriented or distracted by pain and grief to trouble themselves with such trivial tasks.

Can it be concluded that a separated head is capable of consciousness and awareness following the event? Not with any certainty. Further scientific observation of human decapitation is highly unlikely, so it is a question that may remain unanswered indefinitely. But there is much evidence to indicate that for some, death is not instantaneous, which probably offers a truly surreal experience for those few, brief moments. It goes without saying that there are no firsthand accounts to shed further light on the subject.



BIRTH CONTROL OF ANTIQUITY

A natural contraceptive brought reproductive freedom to the ancient world—for a time

Approximately 2,600 years ago—around 630 B.C.—the Greek island of Thera was plagued by drought and overpopulation. According to legend, an assortment of settlers were selected to sail south to establish a colony in more hospitable climes. The men and women apprehensively put to sea, and the winds brought them to the northern tip of Africa. There, the gaggle of enterprising Greeks erected the city of Cyrene, where they encountered a local herb that would ultimately bring them and their progeny fantastic wealth.

The Greek settlers found the plant known as silphium or laserwort growing wild along a thin strip of Mediterranean coastline. It didn't take long for them to discover its value as a food source, and the vegetable flesh came to be prized as a delicious garnish. Pleasant perfumes were also coaxed from its yellow blossoms. The resin extracted from its stalks was used to treat cough, sore throat, fever, indigestion, snake bite, "warts in the seat," epilepsy, and a host of other disagreeable ailments. But of all of the plant's purported virtues, the silphium was certainly most prized for its pregnancy-preventing seeds, which brought the ancient world a highly sought-after freedom: the opportunity to enjoy sex with very little risk of pregnancy.

As word of the birth-control wonder-herb spread through ancient Europe, Africa, and Asia, a market for it devel-



■ Reliable birth control in the 6th century B.C.? That's something to get excited about.

oped rapidly. The seeds became widely used among the world's wealthier nations, including ancient Greece, Rome, Egypt, and India. By some accounts the silphium seed was also a potent aphrodisiac, a property that considerably compounded its perceived value. The Roman bard Catullus famously alluded to its sexual properties in one of his love poems, where he declared that he and his lover would share as many kisses as there were grains of sand on Cyrene's silphium shores. In essence, "We can make love so long as we have silphium."

Despite the efforts of the Cyreneans and their would-be competitors, the silphium industry stubbornly resisted expansion. Men worked long and hard to propagate the plant, but the notoriously cantankerous laserwort mocked all efforts at cultivation. It refused to sprout anywhere outside of its narrow swath of wild growth along the coast of the Mediterranean Sea. Though this limitation necessitated strict guidelines to prevent overharvesting, the natural scarcity served to maintain the herb's high value. Occasional silphium smugglers penetrated the supply chain, but aside from these rare exceptions the royalty of Cyrene main-

tained a comfortable monopoly on civilization's contraceptives.

For centuries the north African city thrived on its laserwort bounty. The seeds of the fickle shrubbery came into such high demand that they were eventually worth their weight in silver. The Roman government went so far as to store a cache of the herb in the official treasury. Most of the primitive silver and gold coins from Cyrene were stamped with images of the silphium, some depicting just a single heart-shaped seed. It is thought by many historians that this ancient icon of unfettered lovemaking is the origin of today's ubiquitous "I love you" heart symbol.

Unlike many other medicines of its time, silphium was not thought of as a mere folk remedy: Scholars and doctors of the day openly praised the plant's effectiveness as a contraceptive. Ancient Rome's foremost gynecologist—a physician named Soranus—wrote that women should drink the silphium juice with water once a month since "it not only prevents conception but also destroys anything existing." During laserwort's heyday, Rome's birth rate decreased considerably despite increasing life

NATURAL SUBSTITUTES?

Science has examined many of the less-effective herbal contraceptives that were employed in subsequent centuries, such as Queen Anne's lace and pennyroyal. Both demonstrated a significant degree of success in preventing or terminating pregnancies in rats. Some relatives of silphium have also been subjected to modern laboratory testing, such as *Ferula asafetida*, which indicated about 40 to 50 percent antifertility effectiveness; and *Ferula jaeschkeana*, which was found to be nearly 100 percent effective when administered within three days of copulation.

■ *Ferula asafetida* is a modern-day relative of silphium with some contraceptive properties.



expectancy, plentiful food, and relatively few wars or epidemics, and some historians cite this as evidence of the herb's effectiveness.

Unfortunately, modern science will probably never determine whether the shrub's seeds were really an effective form of parenthood prevention, nor will it measure laserwort's merit as a medicine. By the end of the first century A.D., following a 50-year decline in silphium numbers, the Roman historian Pliny the Elder recorded the plant's lamentable extinction. The last remaining stalk

of the laserwort was snipped and sent to Emperor Nero as a "curiosity," and thus ended sylphium's 600-year reign.

The cause of the herb's eradication is uncertain; however, the most widely accepted theory is that overharvesting coupled with livestock grazing caused the silphium population to decline beyond recovery. This trend may have started around 74 B.C. when the region was absorbed into a Roman senatorial province. This change gave control of the laserwort crop to a long series of one-year-term governors who were largely motivated by

short-term profits. It is also possible that the natural desertification of the region shrank the plant's already diminutive habitat. As an alternative explanation, some botanists have suggested that the ancient shrub never truly became extinct, and that

the modern *Ferula tingitana* is the same plant; though this explanation is unlikely considering that tingitana has long grown naturally in many areas where laserwort was unable to germinate and it isn't known for any particular contraceptive properties.

The extinction of silphium is now considered

to be among humanity's earliest environmental blunders. If laserwort was indeed more effective than the alternatives, then the bygone birth control is certainly deserving of its glowing reputation. Evidence suggests that the natural world allowed women in antiquity to govern their reproductive lives with far more control than commonly realized and without the need to resort to abstinence. But as mankind is wont to do, the custodians of this scarce commodity eventually surrendered to greed and short-sightedness, overtaxing the renewable resource until it was hopelessly exhausted.

Unlike many other medicines of its time, silphium was not thought of as a mere folk remedy: Scholars and doctors of the day openly praised the plant's effectiveness as a contraceptive.

A BOOGER A DAY KEEPS THE DOCTOR AWAY

A medical doctor describes the health benefits of nose-mining

Mucus is arguably one of the most useful types of goo known to man. The sticky stuff lines many of the pathways into the body's delicate innards, and creates a surface that is like flypaper for bacteria and other tiny undesirables. When invading agents become mired in the muck, the loaded mucus is slowly shuffled out of the body by tiny hairs called cilia. In regards to the nose, when this evicted mucus dries out, boogers are the end product.

There is an Austrian doctor who has gained notoriety by advocating the picking of one's nose and the consumption of the resulting bounty, particularly among children. Dr. Friedrich Bischinger would have us believe that people who practice *rhinotillexis* (the extraction of nose mucus with the fingers) and *mucophagy* (the consumption of the resulting bounty) are healthier, happier, and more in tune with their bodies. His argument stems from the notion that exposing the body to the dried germ corpses helps to reinforce the immune system. The good doctor feels that society should adopt a more progressive approach to booger-eating, and encourage children to adopt the habit.

"With the finger you can get to places you just can't reach with a handkerchief, keeping your nose far cleaner. And eating the dry remains of what you pull out is a great way of strengthening the body's immune system," he said, adding, "Medically it makes great sense and is a perfectly natural thing to do. The nose is a filter in which a great deal of bacteria are collected, and when this mixture arrives in the intestines, it works just like a medicine."

According to some practitioners of nontraditional medicine, the socially boorish activity provides a natural supplement to vaccines. "Modern medicine is constantly trying to do the same thing through far more complicated methods," Dr. Bischinger states. "People who pick their nose and eat it get a natural boost to their immune system for free." Indeed, boogers contain a cocktail of antiseptic enzymes that kill or weaken many of the bacteria that become entangled in it; so it follows that the reintroduction of these crippled microorganisms may afford the immune system an opportunity to produce antibodies in relative safety.

"People who pick their nose and eat it get a natural boost to their immune system for free," Dr. Bischinger states.

Another argument in support of mucus-munching is the hygiene hypothesis, a respected scientific theory that suggests that a lack of exposure to germs

and parasites during childhood leads to increased susceptibility to allergic diseases. By inviting boogers' bacteria back into the body, the immune system is stimulated to develop regulatory T cells. If this theory is accurate, then snot may just be one ingredient in a ghastly recipe for an allergy-free future.

What Bischinger fails to explain is that nose-mining can be a hazardous pursuit. If the skin inside the nose is broken by a careless pick, the blood vessels in that region can occasionally carry booger-borne germs to the base of the brain. If an infection establishes itself there, it can inhibit blood flow, a serious condition known as cavernous sinus thrombosis. It can also lead to other diseases such as meningitis, the inflammation of the brain's protective membranes. (Similarly, squeezing pimples anywhere within the triangular area of the face from the corners of the mouth to the bridge of the nose can introduce infections

to the same blood vessels.) This region is known in the medical community as the "danger triangle of the face." Obsessive-compulsive individuals who pick their nose to an extreme degree—a condition known as *rhinotillexomania*—are at particular risk of such maladies.

Considering that Bischinger is a physician who makes a living on sick people, his advice is best taken with a grain of salt. The notion that the immune system can be reinforced by introducing booger-borne germs into the gut may have *some* scientific merit, but it is certainly not based on any formal experimentation. Perhaps the only way to

know for sure would be to conduct a series of clinical studies where each test subject is administered real boogers or placebo boogers for a period of several months while cataloging each group's susceptibility to disease. Only then can we know with any certainty. How about it, science?



■ Booger therapy: nutritious and delicious.

FEVERISH RESEARCH

The assimilation of bodily fluids in the name of medicine is certainly nothing new. During the early 19th century, outbreaks of yellow fever were causing hundreds of thousands of deaths around the world. The disease began as a fever accompanied by headache, often worsening over several days to include chills, nausea, and vomiting. By the third day, many victims' skin became yellow due to jaundice—hence the colorful moniker—followed soon thereafter by bouts of "black vomit," delirium, coma, and death.

Curiously, yellow fever was most prevalent during the hottest months, virtually disappearing during the rest of the year. No one was certain what was causing the disease, nor how it was transmitted. Supporters of the controversial germ theory of disease suggested that microscopic "seedlike entities" in bodily fluids might be the vehicles of sickness, whereas others blamed environmental factors such as heat, food, and noise.

Stubbins Firth, a medical student in the United States, was so convinced of the latter that he set out to disprove the germ theory using a series of sickening experiments. Over many weeks, Firth made incisions in his arms and poured a patient's "coffee-grounds" vomit over the cuts, poured the vomit into his eyes, fried some to inhale the "regurgitation vapours," and guzzled fresh black vomit samples from suffering patients. Still quite healthy, he smeared patients' blood, saliva, perspiration, and urine over his body. He never contracted the disease, and in 1804 he published his conclusions that the germ theory was nothing more than pseudoscientific claptrap.



It was not until the mid-19th century that the first microbiologists conclusively proved the germ theory, and it was not until the late 1800s that physicians discovered that yellow fever faded in winter because mosquitoes are the primary mode of infection. Later studies indicated that the brave but misguided Stubbins Firth escaped infection because the fluid samples he used came from late-stage patients who were no longer contagious.

BRYUKHONENKO'S DOGS

Bizarre Frankenstein animals and their significant contributions to science

From the 1920s through the 1950s, a Soviet scientist by the name of Sergei S. Bryukhonenko spent countless hours slaving away in his laboratory. In his homeland, he was known as a respected researcher for his influential insights into blood transfusion. Not content with his previous achievements, Bryukhonenko wanted to push his work to the very limits of possibility. His macabre research focused on the feasibility of sustaining life through artificial means. Bryukhonenko's lab became home to all manner of bizarre experiments, and his staff quickly grew accustomed to the sight of disembodied heads and desiccated animal corpses. As ghastly as it was, his findings would prove influential to many modern medical procedures.

Bryukhonenko's intention was to create the world's first fully functional heart-lung machine: in essence, a device that could provide a body with oxygenated blood at times when the body itself could not, such as during invasive heart surgery. By 1925 Bryukhonenko's prototype "autojector" was being demonstrated to the general public. Consisting of automatic pumps, a reservoir for storing blood, and two tubes for injecting and extracting the blood, it was a dangerous, primitive-looking machine by today's standards. However, by most accounts, it was dependable and performed its job adequately.

Still not satisfied, Bryukhonenko got to work on



a new project—one that would take a far more unsettling turn. Determined to learn all he could from his autojector, he began experimenting on dogs. His early experiments focused on liberating canine organs and appendages from the shackles of their bodies. Bryukhonenko's scientists managed to keep a heart beating and a lung functioning independent from their bodies. They could even keep a severed head conscious for short periods.

As incredible as they sound, these claims are supported by scores of eye-witnesses, as well as reliable documentation.

All of these achievements are on display in *Experiments in the Revival of Organisms*, a 1940 film filled with dour Russian nurses and canines in various stages of death. The most amazing

■ Bryukhonenko ran a raft of grisly experiments on unsuspecting dogs.



■ A disturbing example of Dr. Vladimir Demikhov's two-headed handiwork.

and unsettling part in the movie is the famous "dog's head" presentation. In it, technicians place a freshly severed dog's head on a small table. The creature is then fed a supply of air and blood using Dr. Bryukhonenko's system of tubes, pumps, and basins. As proof of the experiment's success, the head is subjected to all manner of stimuli in an effort to show that it is in full control of its faculties while on the machine. Its pupils adjust when exposed to a spotlight, its mouth accepts and swallows candy and licks its snout clean when it is dabbed with citrus. Its eyes tear when an irritant is introduced, and it even reacts to the sound of a hammer being struck nearby.

As if a conscious severed head weren't enough, Bryukhonenko ends his movie by resurrecting a dog from the dead. The process involves draining the blood from a living dog and leaving it for approximately ten minutes. A technician then connects the

dog to the autojector, pumps its blood back in, and waits a short time for the heart to begin working again. According to the narrator, these resurrected dogs went on to live normal lives after their ordeal on the operating table. Unfortunately, you can't trust everything you see in the movies.

Experiments in the Revival of Organisms is not without its detractors. Many argue the film is at best exaggerated Soviet propaganda or at worst an outright fake. It's clear that there is no way to prove the validity of many of the things being shown in the movie. The camera operator does not provide any full-frame shots of the more dubious experiments such as the reanimated severed dog head, nor do they allow any particular shot to go on long enough for serious scientific scrutiny. Taken by itself, *Experiments in the Revival of Organisms* would fail to satisfy anyone not already predisposed to believing it.

With some further probing into Bryukhonenko's research, a few strategic omissions become evident. According to some scientists who claim to have observed these experiments, the severed head only survived for minutes on artificial circulation as opposed to the hours purported by the narrator. Furthermore the resurrected dogs showed evidence of severe brain damage and usually lived no more than a few days.

As if a conscious severed head weren't enough, Bryukhonenko ends his movie by resurrecting a dog from the dead.

Not long after Bryukhonenko's work, a fellow Soviet scientist by the name of Vladimir Demikhov decided that experimenting on one dog head just wasn't enough. Demikhov was famous for his work on canine organ transplants; his research was integral in proving that organ transplants in humans were a realistic possibility. That's why, in 1954, he unveiled the world's first surgically constructed two-headed dog. This involved grafting the head of a puppy onto a fully grown dog. Later experiments included parts of the puppy's upper body. Somehow managing to out-weird even Bryukhonenko's experiments, Demikhov recorded some convincing footage to support his scientific assertions. Unlike *Experiments in the Revival of Organisms*, footage of the two-headed dogs was often filmed in public settings and included longer uncut shots. This lent the Demikhov films a bit more legitimacy, although deception is certainly still possible.

Not to be outdone by its cross-ocean rivals, the United States engaged in its own experiments involving attaching and swapping body parts. In

the 1960s and 1970s, American surgeon Robert J. White of Cleveland, Ohio, embarked upon his own dog-altering endeavor. In 1964 he successfully removed the brain from one dog and implanted it into the neck of another, keeping both brains alive and active for some time. This proved that the brain was an "immunologically sound" organ, meaning that unlike a heart or kidney, the brain can be transplanted with little likelihood of the organ being rejected by the body. In a continuation of this research, in the 1970s White and his team managed to successfully transplant the head from one monkey onto the body of another. The scientists were unable to reattach the severed nerves of the animal, however, so it was paralyzed from the neck down. Understandably angry upon awakening, the monkey's first course of action involved attempting to bite the closest scientist. It was soon clear that the test monkey retained full control over everything above the neck, as it was able to blink, eat, and move its facial muscles.

It's hard to imagine experiments like these being done in the 21st century. With the advent of animal rights groups and growing concern for the plight of mammalian test subjects, tolerating such ethically ambiguous experiments has become a thing of the past. However, the work of these "mad" scientists, while perhaps off-putting, has actually done a great deal for the medical world. Bryukhonenko's autojector paved the way for our modern artificial life-support machines, and Demikhov and White's experiments in organ transplants helped us better understand the body's physiological ability to adapt. Together with the work of other medical pioneers, their research ultimately led to the creation and continued success of surgeries we take for granted today. Without these men and their inhumane experiments, there's no telling when—or if—life-support machines and organ transplants would have become possible.

CAPGRAS SYNDROME

When friends and family are not what they seem

Imagine, if you will, that one by one your friends and family—the people closest to you—are being removed and replaced with exact duplicates. Although they are identical in appearance and manner, you are certain that these people are not your loved ones. They are impostors. While most people would become deeply paranoid in such a scenario, there are some individuals who experience such things every day without fear . . . and just wonder "why?" Such is the life of people stricken with Capgras Syndrome.

A person with Capgras Syndrome suffers from the delusion that one or more of their close friends or family members has been replaced with look-alikes, and they cannot be shaken from this belief in spite of an otherwise clean bill of mental health. In some instances, the person believes that they themselves are, in whole or in part, a duplicate. Unlike the paranoia expected from such a condition, there is not necessarily a motive assigned for the appearance of the duplicates—the patients do not believe someone is "out to get them," but they are at a loss for an explanation why anyone would want to replace their loved ones.

This odd misperception is named after the French psychiatrist Jean Marie Joseph Capgras, who described the case of a "Madame M." in 1923. The woman insisted that identical-looking persons had taken the place of her family. Over time her delusion expanded to include neighbors, friends, and acquaintances. But Madame M. never bothered to get to know these impostors, because it was her belief that each one regularly left to make room for the next double. In all, she eventually claimed to have had more than 80 husbands.

People suffering from Capgras Syndrome can sometimes even doubt their own identity after see-

ing their reflection in a mirror. One man pinched himself on the arm after seeing his reflection at the doctor's office, and wondered aloud whether he and the man in the reflection were the same person. There was also a woman who flew into a jealous rage every time she caught sight of her own reflection, believing this "other woman" was trying to lure her husband away from her. Her husband eventually covered every reflective surface in the house in an effort to keep her from hurting herself. Oddly enough, she had no problem recognizing herself in the mirror of her makeup compact, but anything larger resulted in an assault on the imaginary impostor. Her doctor tried a novel solution: He gathered a number of mirrors of varying sizes and had the woman view herself in each one. He started with the smallest and gradually moved to the next larger as soon as she recognized herself. Ultimately she was able to see herself in a full-length mirror, and she was cured from then on.

In some instances, individuals with the Capgras delusion see duplicate animals or objects rather than duplicate people. One doctor reported a patient who believed that his poodle had been replaced with an identical dog, and another reported a patient who believed that during the

night his running shoes and many other personal possessions were being replaced.

Capgras delusion always centers around just one of the subject's senses. The most common is sight: For example, one person readily recognized his wife on the phone when speaking to her, yet when she arrived in the flesh, he thought she was an impostor. Blind people have also been diagnosed with the disorder, and they believe that the voices of certain loved ones are actually coming from duplicates.

While the causes of Capgras Syndrome are not specifically known, there is no shortage of theories. It has been shown that many people with the syndrome have brain lesions in the right temporal lobe from traumatic injuries, epilepsy, and other causes, yet there are also significant numbers of patients with no such damage. Also, there is a somewhat higher incidence of schizophrenia among people with Capgras, and in New Zealand there is a markedly higher incidence of the disorder among the Maori people than in the general population.

Some early researchers attempted to draw connections to prosopagnosia, a condition that prevents sufferers from being able to recognize faces. By measuring a person's galvanic skin response—the amount of electrical resistance in the skin—scientists

can detect when an individual is experiencing emotions. Patients with prosopagnosia exhibit an emotional response to familiar faces, though they reveal no conscious recognition. With a Capgras patient there is no such emotional response. The patient will, however, remark on the striking resemblance. This test effectively rules out mental illness as a definitive cause, since the emotional center of the brain would subconsciously react to a loved one even with impaired perceptions.

Another proposed cause involves some form of damage or impairment in two lobes of the brain: one site of damage affecting the emotional connections with respect to people's faces, and the other affecting the brain's consistency-checking abilities.

In at least one case, doctors have successfully cured Capgras Syndrome by suspending a prescription of diazepam, yet in other cases symptoms have disappeared after administering antipsychotic medication. To date, no single treatment has been found to be consistently effective, and so far no single theory can explain all the reported cases of Capgras Syndrome. It is known, however, that the human mind uses many interlocking cognitive tricks to fill in the gaps of our observations, essentially building a simulation that allows us to interact with our world and society. When just one or two of those links go awry, the true complexity of that simulation is revealed by the fascinating problems that arise.



■ For sufferers of Capgras Syndrome, every day feels like the invasion of the body snatchers.

CARNIVOROUS GIANT CENTIPEDES

What is 35 centimeters long, has 46 legs, and feasts on animals? You probably don't want to know.

The world has many moist, warm, and dark cavities where phobia-inspiring organisms quietly lurk. The tropical climate of South America's Amazon jungle has an unnaturally large number of such pockets, and consequently that region is home to unnaturally large specimens.

One such example is the *Scolopendra gigantea*, a venomous, red-maroon centipede with 46 yellow-tinted legs. These centipedes are the largest in the world, and they are more commonly known as Amazonian giant centipedes due to their massive size. Adults commonly reach lengths of over 35 centimeters—the length of a man's forearm. Not only are these creatures very swift runners but they are also highly adept climbers, a skill that allows them to scale walls to enjoy some surprisingly ambitious prey.

Centipedes in general are carnivorous, though this term usually refers to a diet of smaller bugs or scavenged remains. The Amazonian giant centipede, however, creeps out at night to stalk even larger victims. Groping through the darkness with its long antennae, the centipede will make a meal out of any number of unsuspecting

small animals, including lizards, frogs, birds, and mice. With one quick motion the *S. gigantea*

snags its prey and injects a surprisingly potent venom. The prey animal is dead after a very brief, thrashing struggle, and the centipede is allowed to gorge itself on the catch.

But the natural hunter's most impressive skill is demonstrated inside the caves of the Amazon jungle. In an environment completely devoid of light, the centipede scurries across the damp floor, stepping over writhing mounds of beetles and bat guano; scales the craggy wall; and clammers toward the center of the ceiling. The giant centipede then grips the stone with its rear legs and dangles its forward segments into

■ Fast, venomous, and nocturnal, the *Scolopendra gigantea* feasts on small animals such as lizards and bats.



NERVOUS ABOUT 35 CENTIMETERS? WHAT ABOUT A 9-FOOT CRAWLIE?

In a bygone era—the Paleozoic, to be precise—there were huge millipede-like creatures that dwarfed even *Scolopendra gigantea*. These enormous arthropods were the largest to ever crawl upon the Earth, growing up to nine feet in length. The fossil record shows a heavily armored exoskeleton mounted on 30 pairs of stout legs. The tracks they left behind were preserved in coal-bearing rocks, and these traces of their scurrying bear an uncanny resemblance to tank or bulldozer tracks.

Time travelers of a nervous disposition might be reassured by the creatures' presumably herbivorous nature and the fact that any stowaway beasts would never survive in today's atmosphere. The animals could only grow to such an extravagant size because the oxygen levels 359 million years ago were much higher than they are today—32.5 percent compared to the current 21 percent—and, perhaps unsurprisingly, because there were no carboniferous predators prepared to take them on.

the cave below. Its front section sways as its legs wriggle through the air in search of the intended target: a passing bat.

The fast-flying bats that live in the cave have little warning of the centipede's presence, and within moments one is snatched from the air in mid-flight. The *S. gigantea*'s toxic venom works quickly as the bat hopelessly attempts to squirm from the grasp of many, many grappling legs, only to succumb to the poison within a few seconds. Over the next hour, still hanging from the cave ceiling, the centipede eats every scrap of flesh from its prey. It then pulls itself back up and climbs down the wall to the dark, damp corner of the cave from whence it came.

These impressive arthropods are not only found in the Amazon jungle—they also thrive on the islands of Trinidad and Jamaica. They are becoming a favorite among exotic pet owners worldwide,



■ This nine-inch *S. gigantea* was found behind a TV in a North London home.

but extreme care must be taken while handling them because the slightest trace of the venom can cause a reaction on the skin. Fortunately, the poison from the alarmingly massive *Scolopendra gigantea* is insufficient to kill a healthy human adult, but it can, however, cause sharp pain, swelling, chills, fever, weakness, and uncontrollable running-away-and-screaming.

CENTRALIA'S HIDDEN INFERNO

In the hills of Pennsylvania, a town has been burning for decades

There is a small town in Pennsylvania called Ashland where old Route 61's northbound traffic is temporarily branched onto a short detour. Exactly why the detour is circumventing a perfectly serviceable road is not immediately clear; however, few passersby pay it any mind—a detour is nothing unusual. But anyone who ventures along the original Route 61 highway will soon encounter a town filled with overgrown streets, ominous warning signs, and great cracks in the earth expelling steam and smoke. These are the smoldering remains of the borough of Centralia.

The coal mining town of Centralia, Pennsylvania, was never a large community, but it was once a lively and industrial place. At its peak it was home to 2,761 souls, but today the population of its cemeteries far outnumbers that of its living residents. The series of events that led to the community's demise—slowly diminishing its numbers to less than a dozen—began in the 1960s.

In 1962, workers set a heap of trash ablaze in the community landfill, a pit that had once been part of a mine. The burning of excess trash was a common practice, yet at that particular spot there existed a dangerous condition: an exposed vein of anthracite coal. The highly flammable mineral was unexpectedly ignited by the trash fire. The flames on the surface were quickly and successfully extinguished, and the firefighting equipment was packed up. But unbeknownst to the townsfolk, the coal continued to burn underground. Over the following weeks it quickly and quietly migrated into the



■ Steam and smoke escape from Centralia's underground fire through a ventilation tube.

surrounding coal mines and beneath the town, causing great concern once it was discovered.

Soon the Pennsylvania Department of Environmental Resources began monitoring the fire by drilling holes into the earth to determine its extent and temperature. As a precaution, the Department also installed gas monitors in many homes within the affected area, but even so many residents complained of symptoms of carbon monoxide exposure. The fire continued to gradually move its way through the underground coal veins, possibly accelerated by the air allowed in by the monitoring boreholes.

A 12-year-old boy named Todd Domboski was nearly swallowed by the earth when the ground crumbled beneath his feet.

The fire had little impact on residents' day-to-day lives, but in 1969—seven years after the fire was started—the Department of Environmental Resources was forced to acknowledge that the fire was not running out of fuel or burning itself out, so a more involved effort was undertaken. Workers dug containment trenches and installed clay seals, but the subterranean fire was too vast to be defeated with such methods. In the 1970s, concerns over the severity of the extensive subterranean fire were stirred again when a local gas station owner discovered that the fuel in his tanks was a troubling 180 degrees Fahrenheit.

Numerous attempts were made to extinguish or contain the underground fire over the next two decades. The mines were flushed with water and the burning coal excavated, but these efforts were unsuccessful. The work continued for years at great expense, with no appreciable progress.

In 1981—after Centralia had been simmering for nearly 20 years—a 12-year-old boy named

Todd Domboski was nearly swallowed by the earth when the ground crumbled beneath his feet. As the 4-foot-wide, 150-foot-deep sinkhole vomited concentrated carbon monoxide, the boy pulled himself from the edge with the help of his cousin. It was not the first nor the last sinkhole caused by the fire, but it was certainly the most sobering. The harrowing incident drew national media attention.

At that point, about \$7 million had been spent in the firefighting effort. Experts determined that the only remaining effective option would be a massive trenching operation, at the cost of about \$660 million, with no guarantee of success. Left with such unpalatable options, the state of Pennsylvania basically condemned the entire town and spent \$42 million in government funds to relocate most of its residents.

The fire continues to burn today beneath about 400 acres of surface land, and it's still growing. There is enough coal in the eight-mile vein to feed the fire for up to 250 years, but experts believe that it may burn itself out in as few as 100 years. A few residents remained in the borough after the buyout, but their numbers have dwindled since then to about a dozen. Most of the unoccupied homes and buildings have been razed, and large portions of the town are being reclaimed by nature. The area is now largely comprised of wild meadows crisscrossed with overgrown asphalt roads, and the occasional hillside riddled with smoking crevasses.

In its prime, Centralia was a vibrant community with five hotels, seven churches, 19 general stores, two jewelry stores, and about 26 saloons. Today it is a modern ghost town whose guts have been burned out and whose main path of ingress has been closed and detoured. Residents are expected to return in 2016 to open a time capsule that was buried in the town in 1966, back when the town's future was still somewhat optimistic. Its future now is decidedly more grim. There are currently no further plans to extinguish the fire, and most modern maps no longer show a dot where Centralia once stood.



CHARLES BONNET SYNDROME

Hallucinations aren't just for crazy people anymore

In the year 1760, a Swiss naturalist named Charles Bonnet became concerned when his grandfather, Charles Lullin, began to experience a parade of "amusing and magical visions." The 89-year-old Lullin was being visited by visions of people, birds, carriages, and buildings, all of which were invisible to everyone but him. Apparently these mysterious objects materialized spontaneously among the few bits of the world he was still able to perceive through his cataracts.

Bonnet's grandfather did not demonstrate any other signs of marble loss; in fact, he seemed quite sane aside from the vivid hallucinations. Moreover, the elderly man was keenly aware that the strange sights were all in his mind. Bonnet cataloged his grandfather's curious circumstances, and over time the condition he described came to be known as Charles Bonnet Syndrome, or CBS. Numerous similar cases have been recorded in the decades since, and though it has long been regarded as a rare disease, recent evidence suggests that it is much more widespread than previously believed.

For those stricken with Charles Bonnet Syndrome, the world is occasionally adorned with vivid yet unreal images. Some see surfaces covered in nonexistent patterns such as brickwork or tiles, while others see phantom objects in astonishing detail, including people, animals, or buildings. These images linger for a scant few seconds or for as long as several hours, appearing and vanishing abruptly. They may consist of commonplace items such as bottles or hats, or brain-bending nonsense like dancing children with giant flowers for heads.

Most of those afflicted with CBS are people in the early stages of sight loss, and the hallucinations usually begin while their vision is still diminishing. The most common trigger is macular degeneration, a disease where certain light-sensing cells in the retina malfunction and cause a slowly worsening blind spot in the center of one's vision. Other eye diseases such as glaucoma and cataracts can cause the symptoms as well, and in a few rare cases it has been diagnosed in people without any detectable vision problems whatsoever. The likelihood of Bonnet visions also seems to increase in individuals who have limited social interaction.

People with damaged sight are often startled by the clarity of these hallucinations. The condition does not cause a series of vague, floating images; the visions are highly detailed, and quite often they will conform to their surroundings. A nonexistent man might sit down and relax in a real-life recliner, or a convoy of poached eggs may drape themselves on a legitimate mantelpiece. Sometimes a significant segment of reality is altered—such as a stair-

case that becomes a steep mountain slope or a room that morphs in size and shape—making the world difficult to navigate. Real objects can even vanish for periods of time, leaving little or no evidence of their prior presence.

One woman was visited by several tiny chimney sweeps in stovepipe hats that paraded around her home.

A significant percentage of patients describe floating, disembodied faces that squirm into their field of vision at random times. These often have wide, unblinking eyes; prominent teeth; and features reminiscent of a stone gargoyle.

Visions of people appear frequently to Charles Bonnet Syndrome sufferers, though familiar faces are seldom seen. Most of the apparitions are strangers, although there are occasional reports of grieving people seeing their deceased loved ones during such hallucination episodes. These phantom people normally wear pleasant expressions on their faces as they loiter in eerie silence, and they make frequent eye contact with the viewer.

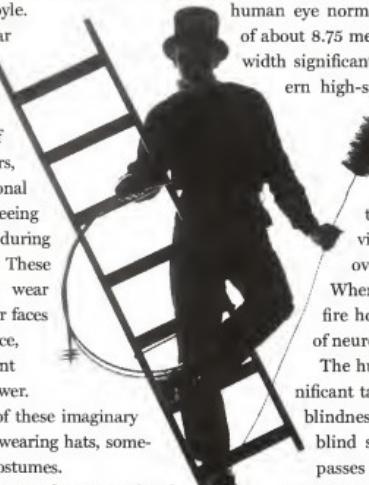
Curiously, a great number of these imaginary characters are described as wearing hats, sometimes along with elaborate costumes.

A Charles-Bonnetter understands at a rational level that the hallucinations are manufactured by the mind, but it is nonetheless troubling to wake up to a room full of strangers or to see vivid faces staring out of the shrubbery. It can also be disconcerting when visions of ordinary objects appear in

ordinary places—such as a bottle on a table or a truck on the street—making fiction more difficult to separate from reality.

Some CBS visions are so outlandish that the viewers describe a moment of astonishment as they bid a premature farewell to their sanity. One woman was visited by several tiny chimney sweeps in stovepipe hats that paraded around her home, and another man spoke of a gaggle of monkeys in blue coats and red hats frolicking in his front yard day after day. Given the basic human tendency to trust one's senses, these hallucinations can stir up lively struggles between emotion and reason.

The exact cause of Charles Bonnet Syndrome is not known, but the popular theory suggests that the brain is merely attempting to compensate for a shortage of visual stimuli. Consider that each human eye normally receives data at a rate of about 8.75 megabits per second—a bandwidth significantly greater than most modern high-speed Internet connections.



The visual cortex is the most massive system in the human brain and it is packed with pathways that manipulate the rush of visual data before handing it over to the conscious mind. When disease begins to kink this fire hose of information, a legion of neurons are left standing idle.

The human brain already has significant talent in dealing with partial blindness. Every human eye has a blind spot where the optic nerve passes through the retina, and the visual cortex automatically fills in these blind spots by extrapolating what *should* be there based on the surrounding detail. Since a person's two blind spots do not overlap, the brain can

■ "I see him, but I know he isn't there."

also cross-reference the eye data when both eyes are active. In gradual-onset blindness, it is possible that these brain pathways attempt to fill in the new obscured areas. Since the eyes are sending reduced amounts of data with a greater frequency of errors, the visual cortex may produce more and more outlandish guesses.

Some have suggested that Bonnet visions are the product of the same mechanisms that generate dreams. Clearly the mind is starved of visual input during sleeping periods, so it stands to reason that both dreams and CBS hallucinations may be the result of the same thing: The visual cortex becomes bored due to lack of stimulation and gratifies itself using stored imagery. This notion is further supported by sensory deprivation experiments, where subjects are placed in complete darkness for long periods of time and eventually begin to hallucinate. This explanation fits the problem imperfectly, however, because dreams include sound and sensations, whereas Bonnet visions are confined to sight.

Formal studies have found that CBS has a higher rate of occurrence in those with higher education and those with creative leanings, which suggests that the concept-association skills inherent in creativity and intelligence may be playing a role. The whole condition is also reminiscent of phantom limb syndrome, where people with missing limbs experience sensations as though the body parts are still present.

Of course there are some who believe that these bizarre Charles Bonnet visions have nothing to do with attention-starved brain cells, but rather they are *real* images from some alternate reality that is parallel to our own. The theory suggests that people cannot normally perceive these parallel realities because they are drowning in a flood of visual data from our own world. It is implied—though not stated outright—that these parallel realities must be strange places where people sometimes have flowers where their heads should be and preposterous theories where their facts should be.

One of the most thorough studies of the phenomenon was undertaken at the University Hospital in Nijmegen, the Netherlands, with the participation of more than 500 visually handicapped patients. During the survey patients were asked whether they had experienced complex visual hallucinations



■ Is this couple real? Or a figment of my imagination?

FIND YOUR BLIND SPOT

You can perceive your own blind spot by using the image below. Simply sit close to the page with your right eye covered, and focus on the word "Interesting." Maintain that focus while slowly moving away from the page, and at a particular distance the logo will disappear although the yellow lines and the word "Damn" will still be visible. If you change your gaze, the logo will no longer be in the blind spot and it will reappear.

DAMN



INTERESTING

in the previous four weeks, and 63 indicated that they had. Psychiatric examination of the patients revealed no other disorders that might cause such side effects. This and other studies suggest that as many as 15 percent of people with vision loss experience CBS hallucinations to some degree. It is even rumored that Charles Bonnet himself followed in his grandfather's footsteps, witnessing his own set of inexplicable visions when his eyes began to fail him later in life.

Given the high rate of Bonnet visions among patients in these studies, it seems that it is not so rare as was once thought. The small number of reported cases is probably due to the sufferers' reluctance to report the strange visions for fear of having their sanity cast in doubt; most of those afflicted with CBS will not speak of the hallucinations at all unless they are asked directly. In contrast, people with psychosis tend to immerse themselves in elaborate fictions to explain their hallucinations and seldom question their own mental health. One of the most effective treatments for CBS is to simply inform the patient that these visions are not a reflection on their mental well-being. Although this may not prevent future

hallucinations, in many cases it greatly reduces the related anxiety.

Some CBS sufferers are able to banish their phantoms by changing their environment in some way—such as turning the lights on or off—though most of the time a patient is subject to their visions' whims. Others have resorted to befriending the apparitions, making idle one-sided conversation as the imaginary guests stare quietly. Fortunately the condition is almost always temporary, and in most cases the visiting visions fade away forever after 12 to 18 months.

Human perception is patently imperfect, so even a normal brain must fabricate a fair amount of data to provide a complete sense of our surroundings. Humans are lucky to have these fancy brains to chew up the fibrous chunks of reality and regurgitate it into a nice, mushy paste that our conscious minds can digest. But whenever one of us perceives something that doesn't exist, or fails to notice something that does exist, our personal version of the world is nudged a little bit further from reality. It makes one wonder how much of this flimsy "reality" we all have in common, and how much is manufactured by our minds.

CLEVER HANS THE MATH HORSE

One scientist's quest to prove that animals are much more intelligent than we supposed

 In the late 1800s, a German high school mathematics instructor named Wilhelm Von Osten was pushing a few scientific envelopes from his home in Berlin. Among other things, he was a student of phrenology, the now discredited theory that one's intelligence, character, and personality traits can be derived based on the shape of one's head. But it was his keen interest in animal intelligence that would ultimately win him fame.

Von Osten believed that humanity had greatly underestimated the reasoning skills and intelligence of animals. To test his hypothesis, he took it upon himself to tutor a cat, a horse, and a bear in the ways of mathematics. The cat was indifferent to his efforts, and the bear seemed outright hostile, but the Arab stallion named Hans showed some real promise. With further tutelage, Hans the horse learned to use his hoof to tap out numbers written on a blackboard. Much to Von Osten's delight, jotting a "3" on the blackboard would prompt a tap-tap-tap from his pupil, a feat which Hans could repeat for any number under ten.

By some estimates, Hans's grasp of mathematics was equivalent to a 14-year-old's.

Encouraged by this success, Von Osten pressed his student further. The scientist drew out some basic arithmetic problems on his chalkboard and

attempted to train the horse in the symbols' meanings. Hans had no problem keeping up with the curriculum, and soon he was providing the correct responses to a variety of math problems including basic square roots and fractions. Hans was proving to be a clever horse indeed.

Starting in 1891, Von Osten began parading "Clever Hans" all over Germany to show off the horse's mathematical proficiency. As word of the spectacle spread, Hans's free exhibitions began drawing larger and larger crowds of curious onlookers. They were seldom disappointed.

"If the first day of the month is a Wednesday," Von Osten would ask Hans, who had learned to respond to verbal questions, "what is the date of the following Monday?" Six hoof taps would follow. "What is the square root of 16?" Four taps. Von Osten also explained to the astonished crowds that Hans could spell out words with taps, where one tap is an A, two taps a B, and so on. Hans would then demonstrate this talent by spelling out the names of people he knew and responding to simple questions. He could also tap out the time



■ Clever Hans and Wilhelm Von Osten show off their tricks in 1904.

of day. Though he made mistakes occasionally, his accuracy was found to be roughly 89 percent. By some estimates, Han's grasp of mathematics was equivalent to a 14-year-old's.

Naturally there were many skeptics, particularly after *The New York Times* featured the horse in a front-page story. Germany's board of education asked to conduct an independent investigation into Hans's abilities, and Von Osten agreed. The board members assembled a number of scientific minds to join the Hans Commission, including two zoologists, a psychologist, a horse trainer, several school teachers, and a circus manager. Following extensive independent testing, the commission concluded in 1904 that there was no trickery involved in Hans's responses; as far as they could tell, the horse's talents were genuine.

The Hans Commission then passed the investigation on to Oskar Pfungst, a psychologist with some

novel ideas on how best to unravel the mystery. Pfungst erected a large tent to house his experiments, thereby removing the contaminating effects of outside visual stimuli. In order to produce a sufficient data set, the scientist compiled a very large list of questions and carefully outlined the different variables that were to be considered.

As expected, Hans performed very well when questions were posed by his owner, Von Osten. He also received very high marks for accuracy with other questioners under normal conditions. But when the questioner stood farther away, something interesting happened: The horse's accuracy diminished.

The final two variables proved to be the most revealing: In instances where the questioner didn't know the answer to a question in advance, the accuracy of Hans's responses plummeted to nearly zero. Likewise when the questioner was completely

concealed from the horse. It seemed that Hans's cleverness hinged on his ability to have an up-close, unobstructed view of the person who knew the correct answer. The researchers also found evidence



■ Hans's apparent mathematic aptitude was 50 percent intelligence, 50 percent perception, and 50 percent luck.

that antagonizing a horse with difficult questions leads to painful horse-bites.

Pfungst continued his experiments, but with a new emphasis on observing the humans interacting with Hans. He immediately noticed that each questioner's breathing, posture, and facial expression involuntarily changed each time the hoof tapped, showing ever-so-slight increases in tension. Once the "correct" tap was made, that subtle underlying tension suddenly disappeared from the person's face, which Hans apparently took as the cue to stop tapping. Pfungst also noticed that this tension was not present when the questioner didn't know the correct answer, which left Hans without the necessary feedback.

Though the experiment strongly indicated that the horse probably had no real grasp of math, it did uncover an extraordinary insight. Hans wasn't dipping into a reservoir of intellect to work out the answers, he was merely being receptive to the

subtle, unconscious cues that were present in his human questioners. Once he became aware of these cues, Pfungst was able to rival Hans's accuracy by placing himself in the "horse" role, tapping out his answers to researchers' questions and keeping a sharp eye on their body language. Even more interestingly, he discovered that questioners seemed unable to suppress these subtle cues, even when made aware of them.

In the intervening years, it has been found that many animals are sensitive to such cues from their human masters. Today, the term "Clever Hans Effect" is used to describe the influence of a questioner's subtle and unintentional cues upon their subjects, in both humans and animals. To prevent foreknowledge from contaminating experiments, modern science employs the double-blind method to

ensure that researchers and subjects are unaware of key details until after the results are recorded. For instance, when drug-sniffing dogs undergo training, none of the people present know which containers have drugs in them, otherwise their body language might betray the location and render the exercise useless.

Wilhelm Von Osten never really accepted the Clever Hans explanation, so he and his horse continued to put on their math-and-body-language show throughout Germany for some time, drawing large and enthusiastic crowds. Though Hans the horse knew nothing of math and had a flimsy grasp of German at best, his ability to fool so many people for so long clearly gives him a legitimate claim to cleverness. Considering his gifts in reading humans' unconscious tells, there's also little doubt that with some opposable thumbs and a stack of bills, Hans would have made one hell of a card player.

COGNITIVE GLITCHES

When it comes to understanding reality, sometimes the human mind encounters some odd bugs

Rather than being an instrument of pure reason, the human brain is first and foremost a tool adapted for efficiency and survival. Sometimes this means processing information in a coldly rational way, but often it means distorting facts to preserve one's particular brand of reality. As a result, our minds are subject to a large number of "bugs" that modern psychology refers to as cognitive biases.



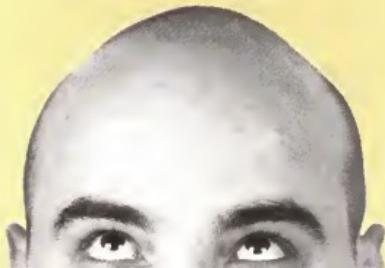
■ **I KNOW IT'S SO, BECAUSE THAT'S WHAT I BELIEVE.** Confirmation bias is among the largest holes in our cognitive underpants. Human thought is fundamentally biased toward seeking evidence that confirms a preexisting belief while ignoring evidence that contradicts it. Nine out of ten examples might show that shampoo doesn't cause baldness, but a person who believes otherwise will possess the remarkable ability to home in on the tenth example and forget all the rest—or will simply never put themselves in a position where they might come across contradictory examples. Thus, even a belief that was arrived at for trivial and illogical reasons is extraordinarily hard to dispel.

■ **I'LL GIVE MYSELF A B+/A-**. The *above-average effect* describes the phenomenon of individuals' rating themselves as "above average" at nearly any skill in which they have an interest. Noting that it seemed a bit far-fetched for everyone to be above average, researchers looked into the matter and reached a troubling conclusion: The more incompetent a person is at a task, the more adept they tend to think they are. The reason for this appears to be quite simple. Someone who is abysmal at a particular skill lacks not only the ability to perform that skill but also the ability to accurately assess the performance of themselves or anyone else. Without solid outside feedback, most people assume they are doing well. Perhaps even more distressingly, the true top performers at a task tend to underestimate their performance compared to others, mistakenly assuming that their peers are much more skilled than they actually are. Together, these two effects can make self-assessment an almost entirely useless metric.

■ **ANY NORMAL PERSON WOULD THINK . . .** The *false consensus effect* is the tendency of individuals to assume that others think and act the same way as they do. It applies to such things as opinions, thought patterns, attitudes, and behaviors. Essentially, false consensus is an expression of the average person's complete inability to comprehend the thought processes of another. The effect is so powerful that subjects asked to envision someone with a different attitude or opinion will often imagine the other person as mentally deficient or deluded. This bias severely limits the ability of humans to understand or predict the behavior of others.

■ **I'D LIKE TO THANK . . . MYSELF.** The *self-serving bias* is the tendency for people to attribute their successes to their own skills and personality traits while blaming their failures on external factors. Meanwhile, the *fundamental attribution error* causes people to blame the mistakes of *others* on those individuals' own personalities. Thus, when someone is late for work, they tend to blame the traffic, the alarm clock, or the vernal equinox, while their coworker assumes it's because they're a shiftless clod. The situation is suddenly reversed when it's the coworker who's late.

■ **CHAIR THE COMMITTEE NEXT YEAR? NO PROBLEM.** It's long been observed that humans generally favor short-term payoffs over long-term gains. As things grow hazier the further we look into the future—an effect known as *temporal myopia*—our brains reduce the importance of that uncertain future in our decision-making. This bias is called *hyperbolic discounting*, and it's the reason why many people take on distant future commitments that they would never accept if they required immediate action; why buyers take out unwise loans to make purchases immediately rather than save their money; and why 90 percent of heart patients disregard their doctors' advice to make lifestyle changes, even when their lives are at stake.



COLEY'S CANCER-KILLING CONCOCTION

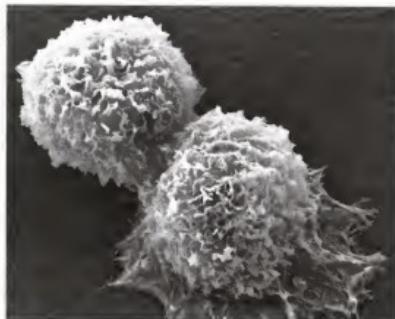
An antiquated and mysterious cancer treatment may pave the way for future medicine

On October 1, 1890, William B. Coley, a young bone surgeon, saw one of his first patients in private practice at the New York Memorial Hospital. Although he'd only just finished his residency, he'd already built a reputation and many considered him a rising star of the New York surgical scene.

His patient—a 17-year-old girl—had a painful, rapidly growing lump on the back of her right hand. She had pinched the unlucky appendage between two railway carriage seats several months earlier, and when the bruise failed to heal, she assumed the injury had become infected. However, the bruise turned into a bulge, the pain worsened, and her baffled doctors eventually called for Dr. Coley. As a surgical man, Coley would never have guessed that this innocuous referral would take his career in a totally new direction—into an unusual branch of medicine now known as cancer immunotherapy.

At first Coley was also uncertain about the diagnosis. But as the girl's lump became larger and more painful, and she experienced a loss of sensation in the surrounding skin, the awful truth became apparent. She had a sarcoma, a type of cancer that affects bone and connective tissue in the body. Unfortunately, 19th-century medicine offered very few treatment options.

On November 8, Coley amputated her arm at the elbow. Although the operation appeared to go well, three weeks later the girl—named Elizabeth Dashiell—developed severe abdominal pain. Soon thereafter she noticed lumps in her breasts and armpits, signs that the cancer was spreading. She



■ Sarcoma cells, the target of Coley's original concoction.

rapidly lost strength and died on January 23, 1891, with a traumatized Coley at her bedside.

While a more experienced physician might have shrugged away the apparent failure and moved on, Coley was determined to do something. He pored through the hospital's records, looking for clues from previous sarcoma cases that might lead to better treatments. He soon found what he was looking for: the case of a German man who'd come to the hospital with an egg-sized sarcoma in his left cheek. There

were several attempts to excise the tumor but none of them was successful. The final operation only partially removed the huge mass, leaving an open wound that subsequently became infected. The unfortunate immigrant was deemed a terminal case.

Yet four and a half months later, he was discharged with no trace of disease. Coley tracked down the former patient to verify that the miracle had taken place, and, indeed, the man was healthy. The records showed that the wound became infected with a commonplace bacterium, *Streptococcus pyogenes*, and the patient went through several bouts of fever. With each attack of fever the tumor shrank, until eventually it disappeared, leaving only a large scar under the left ear. Coley surmised that the infection had stimulated the patient's immune system—as evidenced by the repeated fevers—and that this immune response had eradicated the cancer.

The story so convinced Coley that he cavalierly contrived to contaminate his next ten suitable sarcoma cases with *Streptococcus*. Initially he repeatedly injected a solution of live bacteria deep into the tumor mass over several months. The first patient to undergo this treatment was a bedridden man with inoperable sarcoma in the abdominal wall, bladder, and pelvis. Using this experimental method, the patient was cured spectacularly. He staged a full recovery, and survived another 26 years before dying from a heart attack. But subsequent results were mixed; sometimes it was difficult to get the infection to take hold, and in two cases the cancer responded well to treatment but the patients died from the *Streptococcus* infection.

Coley's discovery, as it turns out, was actually a rediscovery. A 13th-century Italian saint was reputed to have his tumor-afflicted leg miraculously healed shortly after the malignant growth burst through the skin and became infected. Crude cancer immunotherapies working along similar lines to Coley's early

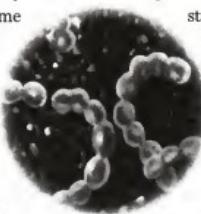
experiments were known in the 18th and 19th centuries, and may extend back to the time of the pharaohs. Ancient writings suggest that the renowned Egyptian physician Imhotep may have used a similar infect-and-incise method to treat tumors.

But Coley took those first important steps to drag the old remedy into the 20th century. After the fatalities with the "live" version of his therapy, he developed an improved fluid containing two different strains of dead bacteria, *Streptococcus pyogenes* and *Serratia marcescens*. He theorized that these bacteria would still have the immune-stimulating capability of their living brethren (in the form of purported "toxins"), but not share their inconvenient tendency to cause deadly infections. His invention became variously known as Coley's Toxins, Coley's Vaccine, Mixed Bacterial Toxins, or Coley Fluid. The treatment was met with considerable success. A

study in 1999 suggested that it was at least equally as effective in treating cancer as conventional modern therapies. With due care in dosing and management of the induced fever, it was also remarkably safe.

Other physicians in America and Europe experimented with the method and found that the toxins appeared to work just as well in a number of non-sarcoma cancer types, such as carcinoma, lymphoma, and melanoma. Furthermore, they could be given intravenously some distance from the site of the tumor and still be effective. Variations on the basic bacterial recipe and different dosing regimes were tried, depending on the individual patient and the particular cancer's type and proliferation. Through his career, Coley himself treated more than 100 patients with his concoction, and many more were treated by other doctors.

Although Coley took the concept of immunotherapy much further than his pharaonic forebears, he had no clear idea how his toxins actually worked, and the tools did not yet exist for him to find out.



■ The *Streptococcus pyogenes* bacteria.

But given the rapid scientific progress at the turn of the last century, he reasoned that a deeper understanding of his therapy would arrive soon enough.

As the fame of his fluid grew, so did Coley's stature: In 1915 he became head of the Bone Service at the New York Memorial Hospital (which later became the Memorial Sloan-Kettering Cancer Center). By the time he died in 1936, Coley's Toxins were mentioned in a number of different surgical textbooks as a standard anticancer therapy.

Conventional modern medicine, however, very rarely employs Coley's Toxins in the treatment of cancer. The reasons it fell out of favor are somewhat obscure, but persisting uncertainties about the treatment may have played a large part. Generally, doctors are reluctant to administer therapies whose workings they don't comprehend. The stimulated human immune system is a whirling tempest of different physiological and biochemical responses, and even now it's not known precisely how Coley's Toxins attacked its cancerous target. One theory stresses the importance of the fluid-induced fever in killing the cancer cells; another considers the debris-engulfing macrophage cells to be the main players, while others consider various immune messenger molecules—or cytokines—to be important.

Even as the success of Coley's Toxins grew, other better-understood cancer therapies were starting to produce results. Soon after Wilhelm Röntgen discovered X-rays in 1895, the possibility of using radioactivity to treat cancer was investigated. Radiotherapy had the advantage of fractional doses, and it didn't require the complicated, patient-specific preparation Coley's Toxins did. Likewise chemotherapy was based on known scientific principles and could be manufactured and used relatively easily.

Furthermore, both radiotherapy and chemotherapy have an immune-suppressing side-effect. Since both treatments kill the rapidly dividing cells of the immune system along with the rapidly dividing cancer cells, they can be used together if care is taken. But immune-stimulating Coley's Toxins work entirely

differently, and their effect would be canceled out if used at the same time as high-dose chemo- or radiotherapy. It became an either/or situation—and in the end, the newer treatments won out over Coley's fiddly reworking of an ancient "natural" remedy.

**By the time he died in 1936,
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standard anticancer therapy.**

So when the U.S. Food and Drug Administration changed the status of Coley's Toxins to that of a "new drug" in 1963—meaning that it could only be used in clinical trials, and greatly reducing its availability—it seemed that its time had already long passed. But cancer immunotherapy does have limited applications today. Perhaps its most frequent mainstream use is in the treatment of bladder cancer. Melanoma, a particularly aggressive type of skin cancer that responds poorly to conventional therapy, is also sometimes treated with an immune-stimulating cytokine called interferon.

In some ways this century-old treatment is still a fringe area of medicine. But researchers are again probing the possibilities of immunotherapy. New antibody-based treatments like MabThera and Herceptin are making a real difference in the treatment of common cancers. Although these therapies don't stimulate the body's immunity as a whole, they are based on antibody molecules that are key components of the human immune system. They show that our increasing knowledge of the molecular nitty-gritty of the body's own defense and repair network is starting to have an impact on the battle against cancer. One tumor at a time, such advances in modern medicine are finally vindicating William Coley and his 100-year-old cancer-killing concoction.

CORPSE ACRES

A facility at the University of Tennessee studies the morbid subject of decomposition

Under normal circumstances, one would expect a wandering throng of students to demonstrate shock and horror upon encountering a human corpse in the woods; particularly a corpse as fragrant and festering as that found on an August afternoon in Knoxville, Tennessee. From a short distance the male figure almost appeared to be napping among the hummingbirds and squirrels, draped as he was over the pebbled ground. But something about his peculiar pose evoked a sense of grim finality—the body language of the deceased.

The students knelt alongside the slumped form, seemingly untroubled by the acrid, syrupy tang of human decay that hung in the air. They remarked on the amount of decomposition that had become evident since their last visit, such as the sloughed skin and distended midsection. The insects that feasted upon the decommissioned man were of specific interest, prompting a number of photographs and note-jottings. After surveying the scene to their satisfaction, the students strolled across the glade to examine a considerably more decayed corpse in the trunk of an abandoned car. Their lack of alarm wasn't altogether surprising, for they were part of the organization responsible for dumping these corpses—along with dozens more—throughout the otherwise serene forest. They were forensic anthropology students from the University of Tennessee.

Affectionately referred to as the Body Farm, the facility was founded in 1981 by Dr. Bill Bass, a professor of anthropology at the university. Before the Body Farm was established, information on human decay was astonishingly inadequate, leaving crimi-

nal investigators poorly equipped for determining abandoned bodies' time of death. On one occasion, Bass was asked to estimate the postmortem interval of some human remains, and conventional methods indicated approximately one year given the moist flesh still clinging to the man's bones. When other evidence later revealed that the body had been occupying its coffin since the Civil War, a flummoxed Bass took it upon himself to finally fill the forensic gap.

In what must have been a lively conversation, the professor convinced the university administration to set aside more than an acre of woodland for his pioneering decay research. The university erected two wrecking-yard-style barriers along the plot's perimeter: an inner wooden "privacy fence" and an outer layer of chain-link. For good measure, they garnished the top of the chain-link with prison-grade razor wire. To discourage those whose curiosity is aroused by pungent breezes and formidable fences, the department installed a series of signs to warn away would-be interlopers. RESEARCH FACILITY. BIOHAZARD. NO TRESPASSING.



■ *A body decays in a water trough at the Body Farm.*

In the intervening years many anthropology students at the University of Tennessee have been engrossed by the decay research at the Body Farm. A continuum of corpses occupy the facility thanks to unclaimed remains from the medical center and persons who have donated their bodies to science.

As the lifeless subjects are interred into the grisly forest hideaway, each is assigned an anonymous identification number. Some are situated to provide interesting decomposition vectors, while others are used to reconstruct specific circumstances for police investigations. At any given time, several dozen perished persons are scattered around the hillside within automobiles, cement vaults, suitcases, plastic bags, shallow graves, and pools of water, or deposited directly upon the earth. Except when clothing is necessary for a particular study, cadavers are disrobed, and factors such as fire and chemicals are frequently introduced to measure their effects. Grad students and professors return periodically to check on the subjects' progress, with occasional visits from police officers or FBI agents undergoing training.

One of the facility's first nonliving participants was Pig Doe, a hog who was anesthetized and

killed on the facility grounds. Within 87 seconds of death a vigilant blowfly made berth upon the unfortunate animal and installed a cluster of eggs, thereby tipping the first domino of decomposition. This represents the main thrust of the research at the Body Farm: forensic entomology, the examination of insect infestation for law-enforcement purposes. When a human corpse is found within 24 hours, the time of death can generally be determined by checking the potassium level in the gel of the eyes or by taking a temperature reading. Beyond that point, it is up to the forensic anthropologists to examine the body and its bug collection.

Technically, decomposition begins about four minutes after death, when cells are deprived of their usual supply of nourishment. Absent these food molecules, digestive enzymes begin gnawing upon the cells themselves, a process called autolysis. Within a few hours the chemicals that allow muscle fibers to slide freely are metabolized, causing a temporary profound stiffness known as rigor mortis. The body pales in color as its blood pools at the lowermost portions.

INSECT DETECTIVES

Forensic entomology is not limited to those insects that feast upon the deceased. For instance, certain insect species can have highly localized habitats, so an automobile's route can sometimes be traced by examining the bugs smashed on the grill. Parasites such as mosquitoes can also act as nature's little DNA collection kits by taking tiny blood samples from unsuspecting perpetrators. Investigators can then erect traps to collect bugs in an area and extract the evidence in classic *Jurassic Park* style. Life finds a way.

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With the human immune system permanently off-line, the digestive bacteria in the gut gain the upper hand, causing an upset in the uneasy intestinal alliance. These bacteria begin nibbling on the body when no other source of nourishment appears. As the host's cells steadily self-destruct from autolysis, their membranes rupture, spilling the nutrient-rich cell filling into the tissues. The bacteria thrive in this river of food, and they soon establish decomposition franchises at every extremity.

Meanwhile, back on the surface, scores of flies are drawn to the fresh-corpse scent from up to a mile away. They lay their eggs at every exposed opening, and within a day the newborn maggots are making a meal of the cadaver's subcutaneous fat. Forensic entomologists can measure the size of these developing fly larvae to determine "time since colonization." Over several days the spongy brain will liquefy and leak from the ears and mouth, while blisters form on the skin that eventually evolve into large, peeling sheets. Often the skin from the hand will slough off in one piece, an effect known as "gloving." Body Farm researchers have discovered that this hand-skin can be soaked in warm water to restore its flexibility, and placed over a researcher's hand for the purposes of fingerprint identification.

By day four or so, the rigidity of rigor mortis has subsided and the rapidly reproducing bacteria have expelled enough gas that the skin takes on a green tinge. The sickly sweet smell of decay begins

to saturate the air as bacterial by-products such as putrescine and cadaverine become concentrated, and the abdomen, groin, and face begin to show noticeable swelling. Writhing mounds of maggots obscure every orifice and a fog of flies swarms above. Maggot-hunting beetles and wasps may join the fray, adding another measurable milestone for the entomologists.

At any given time, several dozen perished persons are scattered around the hillside within automobiles, cement vaults, suitcases, plastic bags, shallow graves, and pools of water, or deposited directly upon the earth.

As the tenth day of decay approaches, the bacteria-induced bloating becomes pronounced. Sometimes this pressure is relieved via "postmortem flatulence," but occasionally an overdistended abdomen will rupture with a wet pop. Ants, moths, and mites begin to capitalize on the corpse cornucopia along with the other insects, while the bacteria continue to dutifully dissolve the internal organs. Soon the soil beneath the corpse is sodden with liberated liquids, while the skin—unappetizing to

most insects—becomes mummified and draws in close to the bones. A buildup of natural soap might also occur as the fats and acids in the body interact, a process known as saponification.

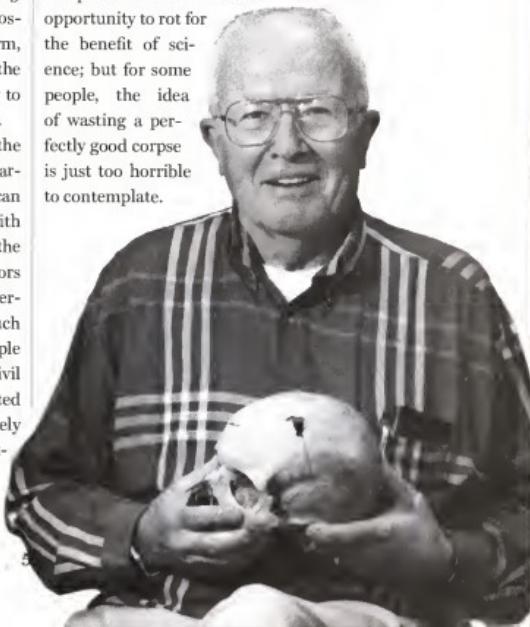
After about 20 days, several generations of maggots have matured or died out, leaving most of the leftovers to molds and flesh-eating beetles. But even after a couple of months, when the flesh is all but gone, forensic entomologists can interrogate the remaining maggots by extracting their juices; investigators can often detect the presence of poisons or drugs since such chemicals tend to linger in the fly larvae. Additionally, the victim's race can sometimes be determined based on the amount of melanin skin pigment that has soaked into the soil.

Although decomposition can be altered by factors such as scavengers, toxins, age, and injuries, most corpses in the wild are skeletonized or mummified according to the formula $y = 1285/x$, where x is the average temperature in centigrade, and y is the total number of days. When the decomposing donors have completed their stint at the Farm, their bones are steam-cleaned and added to the University of Tennessee skeletal archives, ready to return to the aid of science at a moment's notice.

Thanks to the information harvested from the Body Farm—in a feat that is sure to impress at parties—any forensic entomologist worth his salt can now determine time of death when presented with a reasonably fresh unembalmed corpse. Using the results of numerous experiments, investigators have the data to properly adjust postmortem interval estimates, taking into account conditions such as burying, embalming, and weather. One example of such a variation was Bass's underestimated Civil War remains, which were found to be contaminated with lead from the cast-iron casket. This effectively embalmed the body, making the meat unpalatable to tiny foragers.

Bass has since retired from teaching, but he has continued as head of the Forensic Anthropology Center with characteristic zeal. He has also written a number of books about his experiences at the facility. Though the work he pioneered is patently unpleasant, the fruits of his research have helped to solve countless crimes. He stresses the need for similar facilities elsewhere, since Tennessee offers a limited selection of decay conditions. In 2006 another Body Farm was established at Western Carolina University, but numerous efforts elsewhere have been halted only to objections from residents.

While the prospect of having one's naked, lifeless body flung into the woods lacks general appeal—with most people opting to decompose with dignity in the privacy of an overpriced crate—there is nevertheless an ever-growing waiting list of enthusiastic, not-yet-deceased Body Farm volunteers. Bass himself has stated that his hatred of flies compels him to decline the opportunity to rot for the benefit of science; but for some people, the idea of wasting a perfectly good corpse is just too horrible to contemplate.



■ Dr. William Bass holding a bullet blasted skull.



CYBORG SPY KITTIES

You can lead a cat to spies, but you can't make it listen

At the height of the Cold War, the U.S. Central Intelligence Agency was willing to try just about anything to gain an advantage over the dreaded Communists. The agency considered using exploding cigars or seashells to remove Cuban leader Fidel Castro and employed psychics to try "remote viewing" Russian military secrets. They even put the Soviets on the business end of clairvoyant minds to attempt mind-control.

One of the CIA's most bizarre Cold War efforts was Operation Acoustic Kitty. In declassified documents from the CIA's supersecret Science and

Technology Directorate, it was revealed that some Cold War-era cats were surgically altered to become sophisticated bugging devices. The idea was that the cats would eavesdrop on Soviet conversations from park benches, windowsills, and garbage containers.

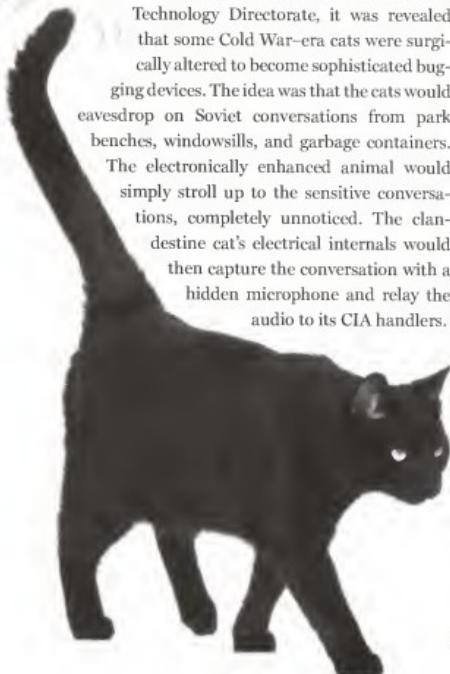
The electronically enhanced animal would simply stroll up to the sensitive conversations, completely unnoticed. The clandestine cat's electrical internals would then capture the conversation with a hidden microphone and relay the audio to its CIA handlers.

The project was funded and work began in 1961. Former CIA officer Victor Marchetti recounts the story of the Acoustic Kitty:

"They slit the cat open, put batteries in him, wired him up. The tail was used as an antenna. They made a monstrosity. They tested him and tested him. They found he would walk off the job when he got hungry, so they put another wire in to override that. Finally, they're ready. They took it out to a park bench and said, 'Listen to those two guys. Don't listen to anything else—not the birds, no cat or dog—just those two guys!'

After several surgeries and intensive training, the cyborg cat was ready for its first field test. In 1966 or early 1967, the CIA drove the cat to a Soviet compound on Wisconsin Avenue in Washington, D.C., and released the Acoustic Kitty from a parked van across the street. The cat ambled into the road and headed straight toward the eavesdropping target, its sensitive microphone pricked to pick up valuable intelligence. The agents eagerly awaited the impending bounty of information from their nondescript surveillance van. As the feline spy approached the far side of the road, however, its mission was abruptly

■ *An inconspicuous secret agent.*



interrupted by the front bumper of a passing taxi.

Five years of research and development were reduced to roadkill in an instant. The documents do not describe any details of the fateful taxi, nor do they indicate whether it was some sort of cleverly disguised Soviet anti-cat technology. Soon thereafter, a CIA operative returned to the accident site and collected the cat's \$15 million remains to prevent the Soviets from getting their paws on the classified listening devices.

Operation Acoustic Kitty was completely abandoned in 1967 and declared an unadulterated failure. Possibly due to their embarrassing nature, the documents describing Acoustic Kitty remain par-

tially censored even today. But one document does praise the Acoustic Kitty team for their efforts:

The work done on this problem over the years reflects great credit on the personnel who guided it, particularly [REDACTED] and [REDACTED], whose energy and imagination could be models for scientific pioneers.

While the memo says that the use of trained cats is *possible*, it also points out that "the environmental and security factors in using this technique in a real foreign situation force us to conclude that for our (intelligence) purposes, it would not be practical."

MYSTERY SIGNALS

Shortwave radio enthusiasts worldwide have heard of the strange and elusive "Numbers Channels." Each of these unusual, off-the-dial AM broadcasts tend to start at very specific times, though each one's point of origin varies from day to day. The signals contain odd elements such as excerpts of music, a regular attention message, and a voice reading out a seemingly random string of phonetic letters or numbers. Spectrum analysis has also found evidence of data bursts buried in the signals. The inexplicable transmissions are fairly common, and though they are most often reported in Europe, they can be found worldwide. Interestingly, there are far fewer today than there were during the Cold War.

No licensed radio station admits to sending these broadcasts, no government admits to sanctioning them, and no individuals confess to being responsible for them. With no evident source or purpose for these signals, imaginations have taken reign and a wide number of ideas have spawned. Theories range from plausible to tittering-alone-in-the-woods-wacky:

- 1) The signals could be a covert means for spy agencies to maintain contact with operatives. This would explain why the messages are so cryptic. Perhaps the transmitters must occasionally move as the field agents relocate in the course of their duties.
- 2) Smugglers and pirates could use the signals to encode messages, thereby thwarting any eavesdroppers.
- 3) Perhaps it's just an ongoing joke perpetuated by a small group of people with malformed senses of humor.

To date, the only government official to admit any knowledge of the broadcasts is a spokesperson for the British Department of Trade and Industry. In 1998 he cryptically told *The Telegraph*, "These are what you suppose they are. People shouldn't be mystified by them. They are not for, shall we say, public consumption."

DAVY CROCKETT: KING OF THE ATOMIC FRONTIER

Dead-simple launch capabilities are paired with the massive destructive power of nuclear weapons



In July 17, 1962, a caravan of scientists, military men, and dignitaries crossed the remote desert of southern Nevada to witness a historic event. Among the crowd were VIPs such as Attorney General Robert F. Kennedy and presidential adviser General Maxwell D. Taylor, who were present to observe the "Little Feller I" weapons test. The main attraction was a top-secret device that was bolted to the roof of an armored personnel carrier—a contraption called the Davy Crockett Weapon System.

At a glance, the Davy Crockett launch apparatus bore a striking resemblance to the hand-held rocket tubes used by soldiers in the Second World War. But the Davy Crockett Weapon System improved on the earlier design in an important and sinister way: It combined this dead-simple launch device with a fission bomb, putting the massive destructive power of nuclear weapons into an easy-to-use and portable package.

Any person within a quarter-mile radius of the Davy Crockett explosion would face almost certain death.

As the threat of Soviet invasion loomed over Europe, U.S. Army officials decided they needed a tool for halting—or at least delaying—the endless

columns of troops and tanks that they imagined might one day pour out of East Germany and the USSR. The task fell to the Los Alamos Scientific Laboratory, where nuclear scientists succeeded in shoehorning an atomic bomb into a "fun size" package. This W54 warhead was then mated with a reliable delivery system, and the resulting weapons were handed over to the Atomic Battle Group for policing the border between East and West Germany.

The Davy Crockett shell weighed about 76 pounds, and it vaguely resembled a watermelon with fins. At 31 inches long and 11 inches in diameter, the projectile was too large to fit inside the gun, so it perched on the top while an attached rod was inserted into the barrel. The shell could be fired from a four-inch-wide tube that could lob the bomb a little over a mile, or a larger six-inch-wide version that could heave it up to two and a half miles. The launchers were mounted to jeeps



The Davy Crockett may look like an oversized metal Q-tip but it had colossal destructive power.

and personnel carriers, and each was operated by a three-man atomic squad. The Davy Crockett was also designed to detach from its vehicle, allowing the teams to relocate on foot and dispatch their miniature mutually-assured-destruction from a handy tripod mount.

The Atomic Battle Group was charged with the protection of Europe between 1961 and 1971, equipped with 2,100 of the convenient nuclear projectiles. In the event of a Soviet invasion, these elite squads were trained to position themselves in the path of the advancing formations. A flurry of mathematics would provide the trajectory and flight time to the targets, and these data would be

used to configure the launchers for maximum carnage. The operators would fire a test shot with a 37-mm spotting gun to verify the angle and timing calculations. The three men would then unpack a Davy Crockett shell from its carrying case, set the egg-timer-style knob to detonate the warhead roughly 20 feet above the target, and select their preferred yield of 10 or 20 tons.

Upon receiving the order to fire, Davy Crockett would fly from its perch with a bang and a cloud of smoke, racing through the sky in a long arc to intercept the advancing enemy. The rudimentary atomic bomb did not include an abort feature, so Davy Crockett was committed to destruction once it was en route. Even with the help of the spotter gun and rifled barrel, the Davy Crockett launcher designs were somewhat imprecise, so the detonation was likely to be several hundred feet from the target. However the weapon's tendency to

spew radiation over the battlefield made up for its lack of accuracy.

Less than a minute after launch, the detonation timer would tick off its final second over the target area. Few specifics are available about the weapon's internals, but it is likely that it contained a 30-pound hollowed-out wad of plutonium wrapped in beryllium and specially engineered "shape charge" explosives. Upon detonation, the shape charges would produce a precision shock wave to crush the plutonium into a small area to create a critical mass, and start nuclear fission.

Any person within a quarter-mile radius of the Davy Crockett explosion would face almost certain

death. Those within the first 500 feet would be exposed to enough radiation to kill within minutes or hours, even with the protection of tank armor. People at about 1,000 feet from the blast would experience temporary fatigue and nausea that would then pass, but this misleading "walking ghost" condition leads to a painful death after a few days of apparent well-being. Those beyond a quarter mile would have better chances of survival, though many would require extensive medical care and perhaps never fully recover from their injuries. Those lucky enough to be more than one third of a mile from ground zero would be spared most of the harmful effects, but the mutations in their DNA would give them an increased risk of cancer later in life.

The Davy Crockett's timer allowed a minimum shot distance of about 1,000 feet, but such inept use of the weapon would certainly result in the deaths of the firing team. In most cases, the approaching Soviets would be at least one mile away, leaving the Atomic Battle Group personnel outside of the hazard zone. Even if the launcher's lack of accuracy resulted in relatively few enemy casualties, the

radioactivity from the hail of fission bombs would render a large swath of earth impossible for about 48 hours, allowing time for American and NATO forces to mobilize.

The rudimentary atomic bomb did not include an abort feature, so Davy Crockett was committed to destruction once it was en route.

In addition to being the smallest nuclear device ever developed by the United States, the Davy Crockett also has the distinction of being the last atomic device tested by the U.S. in the open atmosphere. The 1962 test shot at the Nevada Proving Grounds confirmed the effectiveness of the design, and the device's tiny form factor made it a real crowd-pleaser—or a crowd-killer, depending on one's point of view.

DIAL-A-YIELD NUKE: REGULAR OR EXTRA-CRISPY

One of the most common nuclear warheads in deployment today is the W80, a bomb that has a maximum yield of about 150 kilotons. Such an explosion is overkill for most targets, however, so the W80 is equipped with a control that can reduce its potency to as little as five kilotons. This feature, called "dial-a-yield" or "variable yield," offers just the right level of nuclear destruction for any occasion.

Dial-a-yield works by bolstering the destructive capability bomb through "boosting," the injection of tritium gas into the core of the nuclear device. This feature was first tested in 1951, when nuclear scientists boosted a 20-kiloton fission bomb to an astonishing 45.5 kilotons. Many bombs were subsequently designed with a vacuum-sealed hollow in the center of the fissile material and a knob that would inject a portion of tritium. This simple valve allowed a single weapon design to offer a wide range of power, offering a small-scale "tactical" solution in the same package as a large-scale city-flattening missile.

Due to tritium's scarcity and short shelf life, boosted bombs are now considered obsolete; but they played an important role in increasing the destructive potential of the Cold War.



DEEP WATER MYSTERIES

Strange specimens from the sea

Covering nearly two thirds of the globe, the featureless surfaces of the oceans obscure countless mysteries. Despite advances in technology that enable humans—or their robotic appendages—to reach even the deepest depths, the great majority of the oceans remain unexplored. Much of what is explored is poorly understood, in part because collecting live specimens can be quite a challenge. Here, a look at just a few species that have been found.

■ **LOBSTER BIBS NOT INCLUDED** In 1978, a French research team working in the waters off Tahiti caught ten furry lobsters. Hairy lobsters are unusual, but not unheard of. These ten lobsters were not "hairy," however; rather their shells had a velvety texture. After carefully recording their findings and describing the lobsters' structure, size, and other characteristics, scientific methods would dictate that the lobsters either be kept alive or carefully preserved for further study. Instead the researchers did something that would make them infamous in crustacean research; they ate the lobsters—all ten—for dinner. It would be another 12 years before the species was located again and properly classified. It turns out that the furry lobsters were also capable of making a variety of musical sounds, making them the only furry, musical lobster known to science—a discovery that undoubtedly went unnoticed in 1978 over the enthusiastic bubbling of the lobster pot.

■ **THE BIG BLOOPER** Deep-diving whales such as humpbacks, blues, and rights have adapted to exploit a peculiar physical phenomenon in the ocean known as acoustic wave guides to send loud calls over distances of tens or even hundreds of miles. Very little is known about the purpose of these calls. Several times during the summer of 1997, oceanographers recorded a peculiar sound on the Navy's deep-sea hydrophones that they colloquially called the "Bloop." The sound fit the profile of a living organism, but not even the blue whale—the largest organism on the planet—has the capability to generate such a loud sound. The sound was captured by multiple hydrophones, each spaced 3,000 miles apart. Further study of the Bloop has been hampered by the fact that it has not reoccurred since 1997. As yet, no explanation has been found for the massive biological emanation.





■ **LONELY GIANT** A different mystery sound has occurred reliably for more than 15 years but has scientists equally baffled as to its origins. The sound is unmistakably that of a baleen whale, one of the "great whales" that subsist by filtering tiny krill from the water. But the sound is too high-pitched to be a blue or fin whale, and much too low to be a humpback. By tracking the sound across the oceans, a detailed migratory track has been revealed that matches no known species or group of whales. During the 15-year history, only a single source has ever been recorded at one time, leading researchers to suggest that the call is produced by a single lonely whale. Over the years, the signal has deepened slightly indicating that the whale may have initially been a juvenile and has subsequently matured into an adult. Perhaps the whale was somehow malformed, or a hybrid of two species, and was outcast from its pod, sentenced to forever roam the oceans calling at a frequency where no other whales are listening.

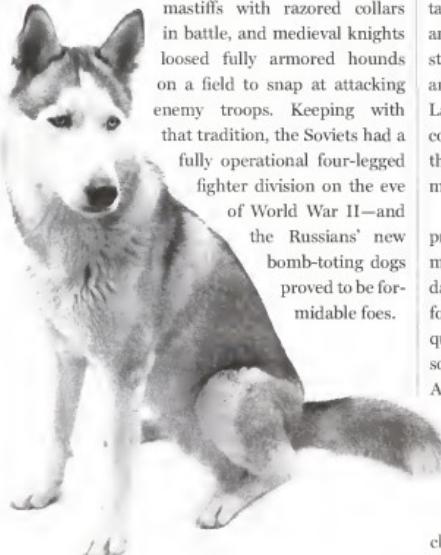
DOGS OF WAR

*How the Russians developed some of the world's first smart bombs.
Good boy. Here's a treat.*

The Nazi blitzkrieg was a revolution in warfare that forced the rest of the world into a wild scramble for a means to halt the onslaught. The German tanks were fast, powerful, and very difficult for the conventional weapons of 1939 to repel. Panzer tanks rolled over Poland with nary a problem, and soon overran most of Europe. The Soviets needed a quick counter-measure against these brutally efficient war machines, and by the time the German invasions developed into a full-fledged World War, the USSR had chosen their means of defeating the tanks: They were going to sic dogs on them.

Dogs have fought wars alongside their masters throughout most of history. The Romans used

mastiffs with razored collars in battle, and medieval knights loosed fully armored hounds on a field to snap at attacking enemy troops. Keeping with that tradition, the Soviets had a fully operational four-legged fighter division on the eve of World War II—and the Russians' new bomb-toting dogs proved to be formidable foes.



Due largely to budget constraints, the Soviets were unable to address the looming threat of Nazi tanks with any new technologies; most plans for antitank weapons were still in the preliminary stages. So the Soviets had to contemplate tackling armored infantry with the means they had at hand. Land mines were a viable option, but because they couldn't count on the Nazis to seek out the mines, they were determined to devise a way to make the mines seek the tanks.

Their answer was found in the dog division. To prepare the dogs for their new combat role, animal trainers would starve the dogs for several days, then teach them that the best place to find food was beneath a battle tank. The hungry dogs quickly learned to seek out the training tank to find some vittles under the vehicle's unarmored belly. According to the plan, once the animals were properly trained they would be fitted with a special bomb satchel attached to their back. If a column of Panthers were to press upon Russia's defenses, these bomb-carrying dogs would be released in their path. When the famished dogs climbed beneath the German tanks in search of



■ The Panzer IV became the backbone of the Nazi armored division.

food, a long lever on the back of the bomb would be pushed, detonating the device and gutting the enemy vehicle.

Implementation of the plan was a little less successful. Since the USSR didn't have any Panthers laying about for training, the dogs had been trained to look under a Soviet tank for food. In the few instances where antitank dogs were deployed, they would sometimes be sent into battle only to turn around and find a familiar tank under which to climb. Sometimes the dogs would spook at the grumble of a running diesel engine and flee from the scene with a live bomb still strapped to their backs. Other times the dogs just decided they didn't want to go, and cowered in their cages while the fighting raged.

Despite these problems, the antitank dogs were successful at disabling a reported 300 Nazi tanks. It was enough of a hindrance to the Nazi advance that the Germans issued orders to shoot all dogs on sight. The top-mounted machine gun of a Panzer tank proved ineffective in this task owing to the relatively small size and fast speed of the canines. Eventually

the Germans began using flame-throwers on the tanks to ward the dogs away, a method that proved quite successful at dissuading the attacks—though it didn't stop all of the dogs. Some would be slowed neither by fear of the fire nor by actually being burned.

In 1942 a large contingent of antitank dogs ran amok, endangering everyone in the battle and forcing the retreat of the entire Soviet division. Soon afterward the dog-bomb project was put down for good.

The antitank dogs were successful at disabling a reported 300 Nazi tanks.

Despite the axing of the antitank program, the Soviets continued to deploy dogs in war. By the end, 61,000 canine soldiers were fighting at the front lines, and dogs were credited with the delivery of 2,000 dispatches, the laying of 7,883 kilometers of telephone cable, and the rescue of 680 wounded soldiers.

DREAMING ON DEMAND

How to control your dreams and alter your dreamscape

In the realm of dreams, some people fly. Some have tea with friends long dead, or fight victoriously as a gladiator in Rome. Others wander through a Dali-inspired world of twisted images. An average person will spend an estimated six years of his life dreaming. For a phenomenon that takes up so much of our time, we have a very poor understanding of what dreams are, and what purpose they serve. Over the centuries, various theories have been bandied about as to the nature of dreams.

Throughout antiquity people have attempted to derive meaning from dreams, and have sometimes credited their nocturnal visions with foretelling, divination, or warning. The ancient Greeks thought that dreams served to heal the body. Many cultures believed that dreams were a conduit through which divinity spoke to them. The first widely accepted modern explanation of dreaming came from Sigmund Freud and Carl Jung. They independently described the dream as interaction between conscious and unconscious will. In 1953 Rapid



■ One person's lucid dream is another person's nightmare.

Eye Movement (REM) was discovered by a medical student named Eugene Aserinsky who later went on to find that REM sleep correlates to the times when people dream. REM is not just categorized by the fluttering of the eyes behind closed lids, but a full-

body paralysis called REM atonia. The discovery of REM and its paralysis prompted a crucial question: What could be happening that was of such value that it warranted leaving a creature paralyzed and vulnerable to real-world dangers for hours every night?

In an attempt to discover what happens to a mammal denied REM sleep, researchers at the University of Wisconsin at Madison devised a simple, though somewhat nefarious, experiment. In a tank of water they set an inverted flowerpot and a rat. The rat could swim about, but if it wanted to rest, it needed to go atop the pot. This worked fine until the animal dozed off; when the muscles slackened, it would slip through the hole in the pot and land again back in the water—while cruel, it effectively let the rat rest while denying it REM sleep. After a few days of this the rat was transplanted into a test environment. Changes in the rat's

■ Dr. Stephen LaBerge

behavior were immediately apparent. It stopped burying foreign objects in its den, it failed to freeze when it encountered a threat in an open field, and basically flubbed every inborn survival reaction of rodent-kind. When pumped with amphetamines, a sleepy rat should react like a wide-awake one for a limited time, but after such an injection the REM-denied rat again failed every test presented. The conclusion was the rat's performance wasn't hampered by lethargy, but by a lack of REM.

The necessity of REM is now generally agreed upon, but its purpose is still far from clear. Studies that look at REM sleep to determine its function propose such possibilities as writing short-term memories to long-term storage, or a theater for people to practice for emergency situations they may one day need to be prepared for. It seems the only thing that is certain when it comes to dreams is that it's profoundly dull when a person tries to relate one in detail.

During a typical dream, the dreamer is subject to the capricious will of the unconscious mind. However, on occasion, the dreamer is able to willfully modify the flow of a dream. Some people have actually mastered the art of shaping their own dreams, hacking their own REM to turn the

dream world in a virtual reality playground. "Lucid dreams" are those where the dreamer is aware that they are dreaming, and may deliberately alter the dreamscape. The power of the dreaming mind is that it may enjoy the full array of perception and sensory stimulation without the strict limitations of reality such as of gravity, weakness, mortality, or morality.

Stephen LaBerge received his Ph.D. in psychophysiology from Stanford in 1980, but his interest in dreams and altered states of consciousness began in his childhood. LaBerge had some lucid dreams of his own, and found it to be a fascinating experience.

Having learned that a person's eyes will trace back and forth when dreaming of a Ping-Pong game, LaBerge went to sleep and allocated the actual work to his trusty research assistant. Before LaBerge began his doze, he and the assistant agreed on a specific eye movement that would serve as a signal that LaBerge was having a lucid dream. The research assistant observed LaBerge's sleep, and verified that he had indeed entered a dream state, and then awaited the agreed-upon signal.

The most widely accepted approach to lucid dreaming is to engulf one's self in a dream then try to gain awareness.

The pair used a polygraph to record LaBerge's sleep pattern, and verify that he was indeed both asleep and able to control the movement of his eyes well enough to signal his partner. Results in hand, LaBerge went to the academic world and proclaimed lucid dreaming to be real. At first there was general resistance to his theory. One fellow scientist said, "There is no evidence that would make me believe [in lucid dreams]." After noting the sci-



entific irony in that statement, however, resistance slowly diminished, and experiments reproduced the same results around the world. In 1987, LaBerge founded the Lucidity Institute to help other people explore the limitless frontier of controlled dreams.

While there are many ways to go about it, there are two primary approaches to the land of lucid dreams. The first is to meditate the mind toward REM while trying to remain aware. This is often called the WILD (wake-initiated lucid dream) method. This method is considered the more difficult because the mind is aware of the strange sensations of falling asleep that we usually ignore. There can be bouts of vertigo, nausea, or out-of-body sensations that can be distressing and cause abrupt wakefulness—meaning that the would-be dreamer must start again.

The more widely accepted method is to come at the dream from the other end—to engulf one's self in the dream, then try to gain lucidity. This is done through the use of "reality checks," and is called the MILD (mnemonic induction of lucid dreams) method. Dreams diverge from reality in many ways, and some of them are fairly predictable. In order to use this method, one must adopt habits while awake that will highlight the differences between the real and the dream. For instance, a person might grow accustomed to glancing twice at the clock—once to check the time, and again to see if the clock remains the same or indicates a radically different hour. Some pinch their nose and try to breathe through it; the flesh nose will be unable to, but the dream nose can breathe unhindered. Some can enter lucidity by merely asking themselves, "am I dreaming right now?" . . . Sometimes the answer will be yes.

Lucid dreaming is an adventure that anyone can theoretically embark upon. To begin, one must:

■ Be able to recall dreams: Many of us can't recall our dreams, or forget them very quickly, but recollection is a skill that can be honed. Keep a paper and pen beside the bed and make a habit of writing every tidbit that can be remembered upon first waking, and generally dream recollection will improve dramatically within just a few days or weeks.



No need to get shut-eye to go to dreamland. You can get there when you're awake, too.

■ Adopt a method to recognize that you're dreaming: There are myriad tricks that will reveal if one is dreaming. Noting and questioning an impossible sight can make a person realize he is asleep, but rather than waiting to see something out of place, most find more consistent success by adopting the "am-I-dreaming?" habits. For instance:

- Try to stick your finger through the palm of a hand. Hopefully while awake, your hand

IF YOU'RE TIRED ENOUGH, EVEN HARASSMENT CAN BE SOPORIFIC

In 1960 a psychiatrist and sleep researcher named Dr. Ian Oswald was attempting to understand why people can sleep through the sort of loud noises and lights that would be undeniably disturbing while awake. How can people sleep soundly though the rumbling of nearby trains or traffic noise? What enables an early-riser to doze through the nagging beep of an alarm clock? Dr. Oswald conducted tests on sleeping subjects, forcing their eyes open and shining a light in there, usually with no notable response. He then tested his drowsy experimentees to see whether they could find their way to sleep amidst much greater distractions.

Once the subject was comfortable, Oswald taped the volunteer's eyes open and set a bank of slowly pulsing lights about half a meter from the subject's face. He also affixed electrodes to the individuals' legs to administer unpleasant shocks. He then added a dash of loud music, and issued the instructions to each subject: Go to sleep.

The EEG of all three showed they'd achieved "deep sleep" within 12 minutes in spite of the cacophony.

Oswald concluded that the rhythmic nature of the stimuli—pulsing lights, regular shocks, and beat-driven music—allows the brain to filter it out. This interpretation was reinforced on a few occasions where the equipment suffered a mechanical problem, interrupting the rhythm and waking the subject.

Oswald published his results in the *British Medical Journal* article entitled "Falling Asleep Open-eyed During Intense Rhythmic Stimulation"—it makes for a great sleep aid.

is too sturdy for a finger to puncture. In a dream, mass is more negotiable.

- Check the time twice in a row. Oddly, this works best with digital watches, as clock dials tend to remain fixed in dreams.
- Toggle a light switch. Most dreams are imbued with a sourceless light that doesn't respond to electrical circuits.
- Seek out a mirror. In a dream, the image seen in a mirror isn't the reflection one expects.
- Explore: In the dream a person can perform any feat of strength, travel to any locale, get

a beer with John Lennon, or cruise the skies like Superman.

Some less-adventurous folks worry that there are dangers inherent to lucid dreaming, but there are no threats evident. In the unconscious realm falling down can break no bones, strain won't cause exhaustion, and the humiliation of going out without trousers is known only to one person. Despite the axiom that "one who dies in a dream dies in true life," a great many people have recorded dreams of their own demise and lived to tell that tale—after all, if everyone who died in their dreams never awoke, who would be able to warn us?

THE DWARF WHO BECAME A GIANT

The consequences of pituitary malfunction

The pituitary is an interesting little gland. Pea-sized, it sits in a bony nook at the base of the skull, quietly producing a cocktail of hormones regulating everything from growth and thyroid production to urine and lactation. Central to the endocrine system, the pituitary can produce effects on the human body completely out of proportion to its diminutive size.

Perhaps the clearest illustration of the pituitary's effects could be found in an Austrian man named Adam Rainer. Born in 1899, it soon became apparent that he was growing older rather faster than he was growing taller. It seemed from early on that he was destined to be an abnormally short man.

What happened to Adam Rainer is called pituitary dwarfism, a fairly rare condition wherein the pituitary gland fails to produce enough growth hormone. Without sufficient growth hormone, growth spurts are truncated or altogether absent, and the child falls farther and farther behind as his peers grow upwards. These days it can be treated with hormone injections, but before the discovery of modern hormonal treatments, there was nothing to be done. So it was with Adam Rainer. By age 21, he stood only 3' 10.5" tall. One can only imagine that by then he had accepted he would live his life as a dwarf. He was wrong.

In his early twenties, Adam Rainer began to grow at an astonishing rate. Over the next 11 years he grew an average of 3.6 inches per year. By the time he was 32 Adam Rainer stood just under 7'2"—a



giant by most standards. He was left bedridden, his muscles unable to keep pace with his rapidly growing skeletal system. His rate of growth did eventually slow, though it did not stop. By the time he died at age 51, Adam Rainer had grown another six inches, making him 7'8" tall.

So what had changed? What could make one man grow so much that he would add almost four feet of height, changing from a dwarf to a giant?

Again the answer lies with the pituitary. One of the most common defects to arise in the pituitary is a benign tumor called an adenoma. Adenomas are fairly common, estimated to occur in over 15 percent of people. Normally they are inactive, left undiscovered due to a lack of symptoms. However, in rare cases they can produce any of a number of pituitary hormones: cortisol (a stress hormone), prolactin (responsible for breast-milk production), or somatotropin—better known as growth hormone.

When an adenoma produces growth hormone,

■ Adam Rainer grew almost 4 feet between the ages of 21 and 51.

the result is called acromegaly or gigantism, depending on whether the victim has finished growing. In an adult with no active growth plates, upward growth is not possible. Instead the hands, feet, and parts of the face enlarge, leading to a characteristic bony look, while the chest grows laterally, becoming barrel-shaped. In a child or adolescent, the growth is upwards. The hands, feet, and face grow in much the same way as for acromegaly, but height is also added, with heights over seven feet being common.

The extreme height and distinctive features of gigantism have been irresistible to Hollywood. Actors Richard Kiel ("Jaws" in several James Bond movies) and Matthew McGrory ("Karl the Giant" in *Big Fish*) both had pituitary gigantism. Even those in other professions frequently seem to end up on the big or little screens. André the Giant and Paul Wright, both professional wrestlers, and Gheorghe Muresan, a basketball player, have all had parts in more than one movie or TV show. Carel Struycken, who played Lurch in the Addams Family movies, was literally pulled off the street when a producer abandoned her car to run after him and offer him a part in *Sergeant Pepper's Lonely Hearts Club Band*.

Unfortunately fame and fortune don't offer much protection against the life-threatening effects of acromegaly and gigantism. Over time they lead to a host of systemic problems including arthritis, diabetes, and heart disease. Back troubles and other effects of extreme growth begin to show. The tumor itself, aside from its hormonal effects, can grow too large, pressing against the optic nerves and causing blindness. Untreated acromegalics and pituitary

giants rarely live past middle-age. Early treatment could avoid most of these problems, but early diagnosis—let alone treatment—is hard to come by. Most of those stricken go a decade or more between the onset of symptoms and a diagnosis. Even someone as drastically affected as André the Giant didn't receive a diagnosis of acromegaly until well into his pro-wrestling career, after much damage had already been done. His death in 1993 was directly attributable to the disease.

Today, treatments for pituitary problems are readily available. Surgical measures were first attempted in 1908 when Dr. Julius von Hochennegg successfully pioneered a method where he accessed the pituitary by punching through the back of the nose to remove the tumor, an approach still favored by surgeons today. A handful of drugs can also be used to alleviate the problems of excessive growth

hormone and to try to shrink the tumor, though they are expensive and not very effective. Pituitary dwarfism can be successfully treated in developing adolescents by simply administering synthetic growth hormones.

Unfortunately none of these treatments were available for Adam Rainer. The drugs that might have treated his dwarfism or tamed his excessive growth had not been discovered yet. Surgery remained a desperate gamble until well past his death, when the advent of antibiotics removed the terror of infection. He is thought to be the only person ever to be classified as both dwarf and giant. Perhaps he was proud of his place in the record books, but it's not hard to imagine that he might have preferred a more normal stature.



■ Polar opposites, a giant and a dwarf pose together.

EARTH'S ARTIFICIAL IONOSPHERE

Scientists seed space with half a billion copper needles to aid in Cold War communication

At the height of the Cold War, in the late 1950s, the concept of Mutually Assured Destruction guaranteed the world a perverted kind of peace. If either the United States or Soviet Union attacked the other, the nuclear counter strike would be immediate and devastating. To maintain these networks of world-ending weapons and early-warning detection systems, the United States military required constant communication among a far-flung international network of bases, outposts, and missile installations.

If for some reason that communication was interrupted, it likely meant that a nuclear first strike was underway, which would trigger a near-automatic retaliation. To make this system fail-safe, an uninterrupted means of communication was sought. The Space Age had only just begun, and the communications satellites we rely on today did not yet exist. At the time, all international communications were either sent through undersea

cables or bounced off the Earth's natural ionosphere—the electromagnetic region at the far reaches of

the atmosphere. If the communication cables were cut by a hostile force or a natural disaster, it would leave the unpredictable ionosphere as the only means of communication.

The U.S. military's idea for solving this was to create an artificial ionosphere that improved upon the natural atmosphere's signal-sending reliability. In May 1963, the U.S. Air Force's Project West Ford launched 480 million tiny copper needles into orbit, briefly creating a ring encircling the entire planet. The engineers involved hoped it would serve as a prototype for two more permanent rings that would forever guarantee their ability to communicate across the globe.

Though the project's first launch attempt ended in failure when the rocket failed to release its payload, the second launch went off without a hitch on May 10, 1963. Inside the West Ford

■ The West Ford dipoles were 1.8 centimeters long and a barely visible 0.0018 centimeters in diameter.

THE CORONA OF COMBUSTION

When a spacecraft or object enters a planet's atmosphere, the corona of combustion that engulfs it is not due to friction with the air as is commonly believed. At the supersonic speeds of reentry, much of the air beneath the craft cannot move aside fast enough and becomes trapped and compressed. When a gas is compressed, its temperature increases in a process known as adiabatic heating. Of course friction also plays a role in reentry heating, just not a significant one. If the reentering object is massive and compact—like a spacecraft or asteroid, for instance—the buildup of heat can reach several thousand degrees Fahrenheit. But most commonly, tiny specks of interplanetary dust and debris slowly settle into the atmosphere relatively intact.

spacecraft, the needles were packed densely together in blocks of a naphthalene gel designed to rapidly evaporate in space. The entire package of needles weighed only 20 kilograms, yet contained half a billion needles that upon release gradually spread throughout their entire orbital ring over a period of two months. The final donut-shaped cloud was 15 kilometers wide and 30 kilometers thick. It encircled the globe at an altitude of 3,700 kilometers.

The West Ford copper dipoles were each 1.8 centimeters long, a barely visible 0.0018 centimeters in diameter, and weighed a mere 40 micrograms.

The West Ford copper dipoles were each 1.8 centimeters long, a barely visible 0.0018 centimeters in diameter, and weighed a mere 40 micrograms. They were designed to be exactly half the wavelength of the 8,000 MHz microwaves commonly used to transmit long-distance communications. This would create strong reflections when the microwaves hit the copper needles, causing them to repeat any signal directed toward them.

The first attempt at remote communications using the West Ford belt was made on May 14, four days after the launch. At that point the dipoles were very densely spaced since they had not yet spread out to fill their entire orbit. Using two 18.5-meter microwave dish antennae, Project West Ford engineers managed to send voice transmissions between Camp Parks, California, and Millstone Hill, Massachusetts. The voice connection was described as "intelligible" and transmitted at a data rate of approximately 20,000 bits per second—about the speed of a 1992-era telephone modem. But as the needles continued to disperse, the data rate dropped off significantly—so much so that by June 18, the transmission rate fell by 5,000 percent to 400 bits per second. On July 2, researchers terminated Project West Ford. By this time, calculations showed that the tiny needles were orbiting about 400 meters apart.

Despite its technical success, the ultimate goal behind Project West Ford was never realized. Serious scientific opposition to the project sprung up almost immediately after it was first proposed in the late 1950s. Though West Ford's cloud of dipoles was carefully designed to return to Earth within a few years of launch, a fully functional cloud dense enough for robust communications would be a permanent fixture of Earth's orbit.

The West Ford belt was visible only in the first few days after launch, before the needles drifted apart. A denser belt intended for permanent communications would probably not have been visible except by very powerful optical telescopes. Like the West Ford belt, the needles in a permanent belt would only have been visible to the naked eye very shortly after launch. But at radio and microwave frequencies, the permanent belts would have become scars on the night sky, forever obscuring the universe beyond. Considering the profound discoveries about our universe that have been made using radio and microwave telescopes, that would have been a high price to pay.

Ultimately, it was not opposition from prominent scientists that killed Project West Ford. By 1963, communications satellite technology had become more and more capable. Compared to these sleek products of space-age technology, the relatively low-tech West Ford cloud was an unsightly dinosaur. However, the West Ford engineers remained

convinced of the feasibility of their endeavor, and largely blamed the end of the program on opposing scientists rather than the advance of competing technologies.

According to both theoretical calculations and observational evidence, most of the West Ford dipoles reentered Earth's atmosphere sometime around 1970. The needles slowly drifted down to the Earth's surface, unscathed by reentry due to their diminutive size. Consideration was given to recovering some of the dipoles in order to learn more about the space environment. Calculations showed that as many as five dipoles would have landed per square kilometer in the arctic, but the exceptional cost of recovering these tiny needles from the proverbial haystack of snow made any attempts at recovery implausible. Back in space, the failed 1961 spacecraft and some larger clumps of the 1963 dipoles remain in orbit like so many pieces of space junk, silently carrying the abandoned hopes of this nearly forgotten experiment.

THE ETHYL-POISONED EARTH

How one man severely tainted the global environment . . . twice

PART ONE

In the early 1900s, automotive engineers began to bump up against the upper limitations of the newfangled internal combustion engine. They needed to increase compression to squeeze more power from the gasoline-fed contraptions. However, there was a certain threshold where a mysterious engine-wrecking condition known as "knock" or "ping" would always arise. Ping had also proven problematic in aviation, preventing the development of higher-performance aircraft engines. Automakers were eager to find a solution; not only would higher-compression designs offer greater horsepower but they would increase fuel efficiency at a time when America was facing a gasoline famine.

In 1921, a clever but chronically catastrophic chemist named Thomas Midgley made an announcement that changed the world: He had developed an inexpensive chemical agent that eliminated these ping problems altogether. The world eagerly embraced the fuel additive, and once again progress in automobile and aviation engines was afoot. However, the invention would soon drive men to madness and ultimately lead to an epidemic of crime, a trail of bodies, and an irreparably tainted environment.

Midgley's foray into fuel-additive research began in 1916 while he was under the employ of General



Motors. At the time no one knew exactly what caused the pesky ping, but researchers had found that a blend of ethyl alcohol and gasoline would allow for much higher engine compression. These blended fuels were much too expensive and they had an inferior energy-to-weight ratio. However, they provided a tantalizing hint that the solution may merely be a matter of fuel chemistry.

Working in his laboratory at the General Motors Research Corporation, Midgley pinched all kinds

■ *The infamous chemist Thomas Midgley.*

of compounds into his test engine—including such unlikely materials as camphor and melted butter. One day Midgley's boss, Charles Kettering, pointed out that certain red flowers were able to bloom in the snow, suggesting that red-colored substances might have greater heat absorption.

The chemists were unable to locate any red dye in the lab, so they tried adding a splash of violet-colored iodine to their fuel. The iodine noticeably reduced the knock in their test engine, but unfortunately it was too corrosive and expensive to consider as an additive.

When the researchers managed to locate and try some actual red dye, it had no effect; their red-color reasoning had been flawed, but fortuitous.

Given the guidance of the accidental iodine discovery, Midgley's team tacked sections of the Periodic Table of Elements to the laboratory wall and began to explore similar elements with promising properties. Other knock-reducing additives were indeed identified, but all of them shared an unfortunate trait: They produced a powerful and foul odor. "I doubt if humanity, even to doubling of fuel economy, will put up with this smell," Midgley confided in a letter to a colleague. Some hope still remained among the heavier carbon elements, however. Midgley slipped a bit of silicon into his test engine with no useful results, and his introduction of germanium similarly failed to improve the fuel. But when he started up the engine with a pinch of a tin-based liquid called tetraethyl tin, it ran at high compression with very little knock.



In addition to supervising Midgley's work, Charles Kettering also invented the electrical ignition system for cars.

Even more encouraging, there was no objectionable odor. Only one additive candidate remained to be tried: tetraethyl lead (TEL).

The researchers cooked up a modest batch of TEL on December 9, 1921, and squeezed a few drops into their test rig. This tiny amount of lead completely silenced the engine knock, much to Midgley's delight. According to eyewitnesses, he and his men danced "a very unscientific jig" in celebration.

It was not until later that engineers discovered the specific cause of engine knock. Ordinarily the fuel/air mixture

inside a cylinder burns in a rapid yet orderly fashion, but there was a certain threshold of heat and pressure where the fuel would explode all at once, releasing its energy too quickly and causing massive destructive vibrations. The smidgen of TEL had increased the temperature at which the gasoline ignited, a fuel characteristic that would come to be known as its octane rating.

A lead-based additive was very appealing considering that lead was abundant and inexpensive. Lead had one decisive drawback, however, which was its tendency to cause pesky deposits in blood, bones, and brains. Lead poisoning was known to lead to alarming maladies such as hallucinations, seizures, blindness, kidney failure, brain damage, madness, coma, and death. Even worse, the effects were often caused by "slow, subtle, insidious saturation" rather than significant exposure events. But in spite of lead's well-known neurotoxic qualities, it was still common in the U.S. in the 1920s and used as a major component in food containers, house paint, and fruit pesticides, among many other things.

As Midgley labored to perfect his TEL recipe throughout 1922, the world outside of the U.S. was developing a strong preference for all things

unleaded. Midgley received numerous letters from distinguished scientists around the world urging him away from the "creeping and malicious poison" of tetraethyl lead, citing its role in the death of researchers. The warnings went unheeded.

General Motors was well aware of the dangers of tetraethyl lead, as indicated in a letter from GM president Pierre du Pont where he described TEL as "a colorless liquid of sweetish odor, very poisonous if absorbed through the skin, resulting in lead poisoning almost immediately." In December 1922, the U.S. Surgeon General wrote to GM regarding growing concerns that accumulated environmental lead would become a serious menace to public health. Midgley responded personally, even as he prepared to winter in Miami for some "fresh air" to treat his own mild case of lead poisoning. The matter of TEL pollution had been given "very serious consideration," he wrote, but "no actual experimental data has been taken." Nonetheless, he stated that "the average street will probably be so free from lead that it will be impossible to detect it."

To manufacture and market its incredible new engine-enhancing additive—which had been dubbed "Ethyl"—General Motors partnered with Standard Oil and DuPont to form the Ethyl Gasoline Corporation. Charles Kettering was installed as the president, with Thomas Midgley as vice president. Their product went on sale in 1923, and consumers showed immediate interest. On Memorial Day 1923, the first-, second-, and third-place winners of the Indianapolis 500 were all fueled by new Ethyl gasoline, lending credibility to the Ethyl Corporation's mechanical claims.

Thenceforth the fortified fuel enjoyed rapid widespread adoption.

Shortly after the Ethyl factories began to produce their product, the mind-dulling effects of lead began to manifest in the workers. Disorientation, impaired judgment, and a staggered gait plagued the lead-polluted employees. The larger Ethyl-pro-

THAT'S what you say when your car won't start? You can't get into it? And you don't like to be left behind. So you remember this:

THE next time you see a friend who's got a new, prissy car, just drive past. If you buy a new, high-compression auto, you'll be of course use Ethyl. But if you must make your old car do a whole longer, give it Ethyl—and feel the difference. You'll find that as harmful knock and sputtering disappear.

These days, when we have to do without so many things, we can't afford to have motor trouble. And even if you don't measure the fun of driving in dollars and cents, you'll find that gasoline plus Ethyl makes you feel younger—on lowered repair bills. Ethyl Gasoline Corporation, New York City.

NEXT TIME STOP AT THE **ETHYL PUMP**

■ A 1933 ad promised that Ethyl would rejuvenate old cars.

ducing facility in Deepwater came to be known as the "House of Butterflies" owing to the frequent reports of insect-related hallucinations. As Ethyl handlers began to turn up at doctors' offices, hospitals, and morgues, the Ethyl Corporation was quick

to blame the victims. "We could not get this across to the boys," Charles Kettering claimed. "We put watchmen in at the plant, and they used to snap the stuff at each other, and throw it at each other, and they were saying that they were sissies. They did not realize what they were working with."

To investigate the possible harmful effects of Ethyl, the Bureau of Mines conducted tests for General Motors in 1923. GM management, however, stipulated that they must approve any findings prior to publication. The Bureau of Mines exposed various animals to leaded gasoline exhaust from a small engine and they found that the animals were "without harm of any kind." Other men of science decried the experiments as inadequate, pointing out that the animals were exposed to a passing stream of lightly leaded exhaust rather than lingering accumulations.

In October 1924, following the death of one worker and irreversible derangement among others at an Ethyl factory, the facility's chief chemist explained to reporters that "these men probably went insane because they worked too hard." Within days, however, four additional workers from the plant died, and 36 others were crippled with incurable neurological damage. The plant, it seemed, had employed many hard workers.

Meanwhile, Midgley addressed the press. He drizzled the syrupy Ethyl fluid over his hands and told them, "I'm not taking any chance whatever." He inhaled the fumes deeply to demonstrate their harmlessness. "Nor would I take any chance doing that every day." The reporters dutifully passed this comforting anecdote on to their readers, and consumers' concerns were calmed.

As demand for Ethyl additive increased across the country, the U.S. Surgeon General launched a series of public inquiries regarding the health risks of leaded fuel. In response, Ethyl voluntarily withdrew its product from the market for the duration

of the investigations. Over a dozen Ethyl-related deaths and hundreds of manufacturing injuries were scrutinized, but per usual these events were blamed on workers' carelessness. The Surgeon General's committee found no firm evidence of a threat to the public, but its members pointed out that its timetable had been insufficient for a thorough investigation, and they strongly recommended further studies.

Ethyl-peddlers enjoyed rabid federal protection, in one instance successfully suing an unleaded gasoline maker who offered a high-octane alternative.

The public took this finding as a clean bill of health, and soon Ethyl was pumping again. Each year the demand increased, and by 1963 Ethyl and other lead-based antiknock agents were present in 98 percent of the U.S. gasoline supply. Thousands of tons of toxic metal were excreted from millions of tailpipes. In the meantime, the Ethyl-peddlers enjoyed rabid federal protection, in one instance successfully suing an unleaded gasoline maker who offered a high-octane alternative that "stands on its own merits" without the need for "dangerous chemicals." Unfettered by facts, the U.S. Federal Trade Commission stated that leaded gas was "entirely safe to the health of motorists and the public [...] is not a narcotic in its effect, a poisonous dope, or dangerous to the life or health of a customer, purchaser, user, or the general public." Ethyl, it seemed, had been exonerated. The lead-additive industry might have gotten away with it, too, if it wasn't for those meddling geochemists.

PART TWO

In the late 1940s, a graduate student named Dr. Clair Patterson was experimenting with a new way to determining the age of rocks, with the ultimate goal of discovering the age of the Earth itself. His method relied upon measuring lead and uranium isotopes in rock samples, but each sample he tested was found to contain about 200 times more lead than it should. Befuddled, Patterson established a contamination-controlled laboratory for his geochemistry experiments, allowing him to determine that the source of the extra lead was the atmosphere itself. By 1953 he had mass-spectrographed enough sterile samples that the Earth's age could safely be estimated as 4.55 billion years—a value which still stands today—then he directed his attention to the massive amounts of airborne neurotoxic lead.

Upon learning that automotive fuel was the source of the contamination, Patterson began to publish materials discussing the toxic metal's ubiquity and its probable ill effects. To demonstrate the increase of lead in the environment, Patterson proposed plucking some core samples from pack ice in Greenland and testing the lead content of each layer—a novel concept that had not been attempted before. The experiment worked, and the results showed that atmospheric lead had been negligible before 1923 and had increased alarmingly ever since. The ice cores indicated that lead levels were roughly a thousand times higher in 1965 than they had been in the pre-Ethyl era. He also compared modern bone samples to that of older human remains, and found that modern humans' lead levels were hundreds of times higher.

The Ethyl corporation allegedly offered him lucrative employment in exchange for more favorable research results, but Patterson declined. The geochemist became the scientific spearhead of the anti-atmospheric-lead movement, and for a time he found himself ostracized from government and corporate-sponsored research projects—including the National Research Council panel on atmospheric lead contamination. The Ethyl corporation

had powerful friends, including a Supreme Court justice, members of the U.S. Public Health Service, and the mighty American Petroleum Institute. Nevertheless, Patterson was unrelenting, and he gradually managed to draw scientific and public attention to the lead dilemma. In an effort to postpone the destruction of mankind, the United States eventually passed the Clean Air Act of 1970, which required a staged phaseout of leaded gasoline. But Ethyl and DuPont sued the Environmental Protection Agency, claiming that "actual harm" must be demonstrated rather than just "significant risk," a gambit that managed to prolong Ethyl's life by another decade.

The ice cores indicated that lead levels were roughly a thousand times higher in 1965 than they had been in the pre-Ethyl era.

By 1986, Ethyl and its ilk were virtually eliminated from the United States, and Americans' blood-borne lead levels have since dropped by 78

percent. Lead's effects, however, may linger much longer. An estimated seven million tons of the stuff were burned in Ethyl's 63 years of use, and because lead does not decay, every particle that traversed a tailpipe still lingers in the air, on the ground, or in the sea. The contamination continues as well; some leaded fuel is still used in aviation and third-world countries, and certain industrial processes also expel lead as a waste product.

The specific harms done by environmental lead are difficult to quantify. It is known that children are much more apt to absorb the neurotoxic metal than adults, and it is considered a likely cause of behavior problems, learning difficulties, hyperactivity, and breathing complications. Even more troubling, scientific studies have shown a strong correlation between atmospheric lead levels and crime rates. A study published in the peer-reviewed journal *Environmental Research* used data spanning more than 50 years to show a "very strong association" between the exposure of young children to lead and crime rates 20 years later when they became adults. This correlation holds true for a wide variety of locales, social conditions, and models of government. The sharp decline in U.S. crime rates that began in the early 1990s dovetails perfectly with the reduction of leaded gasoline in the early 1970s, and other countries that followed suit saw similar declines on a 20-year delay. In another study Pittsburgh University researchers found that juvenile delinquents had lead levels four times higher on average than law-abiding adolescents.

As for Thomas Midgley, the father of leaded gasoline continued his distinguished career by inventing chlorofluorocarbons (CFCs), the refrigerants and aerosol propellants that famously destroyed a considerable section of the Earth's ozone layer before they were banned. Along the way Midgley received an awesome array of awards for his contributions to chemistry, many of which were later regretted upon discovering the damage done by his innovations. He did not survive to witness the disassembly of his successes, however. After becoming impaired by a polio infection, Midgley devised a machine with motorized pulleys to assist him in rising from bed and turning over. One day in 1944, as his automatic contraption sprang into action, he was ensnared in the cords and strangled to death.

Some historians have argued that Midgley's tetraethyl lead was a necessary evil, one that hastened the progress of efficient engines, thereby advancing

the economy and contributing to Allied victory in World War II. It is worth noting, however, that in the early years of Ethyl's availability, basic refinery advances boosted the base octane of fuel by 20 to 30 points, whereas Ethyl additive only raised it by about 9 points. In retrospect, Ethyl's octane improvements were somewhat overstated and the product owed most of its success to crafty marketing, misleading research, and chronic government incompetence. Whatever Ethyl's benefits, it saturated the planet with an insidious poison, and the true magnitude of its past, present, and future harm are yet to be known.



* An antique neurotoxin dispenser.

THE EXPLODING LAKES OF CAMEROON

Under certain conditions, seemingly normal lakes can be deadly

On the night of August 15, 1984, a truck sagging with the weight of a dozen passengers trundled along a misty road in Cameroon, Africa. The vehicle suddenly sputtered and stalled. The driver turned the key, but the churning ignition was unable to restart the engine. Most of the Cameroonians clambered out of the vehicle to investigate, but two remained atop the truck. Within a few moments, each of the ten passengers who had stepped off the vehicle slumped to the ground. A few minutes later, they were dead.

Those unfortunate travelers were not the only people in the area to die mysteriously that night. In the neighboring low-lying villages, 27 other residents inexplicably passed away in their sleep, and an unspecified number of animals perished in the vicinity. Investigators were at a loss to explain the mass fatalities. Interviews with surviving villagers indicated that a distant explosion had been heard sometime after sunset and that a light mist had appeared soon thereafter. A survey of the area found that nearby Lake Monoun had taken on a rusty tinge. But these clues were not consistent with any known weapon or natural disaster. It was not until about two years later that authorities ascertained that a *mazuku*, or "evil wind," had swept through the valleys of Cameroon that night, originating from the shores of the discolored lake. The water had not been tampered with by terrorists, however, nor was it the site of a volcanic eruption. The lake itself had exploded.

Although to the naked eye Lake Monoun resembles an ordinary lake, it is actually rather abnormal. Its basin is unusually deep—more than 300

feet—and its walls are steep-sided, which means surface winds are unable to produce enough turbulence to intermix the lake's layers of water. For this reason, Lake Monoun's cold lower stratum remains undisturbed for decades—or even centuries.

Hundreds of thousands of tons of captive gas were belched from the depths of the lake in a matter of moments, blowing the top off the lake with tremendous force.

This stagnant lower layer is not menacing by itself, but Monoun is also located directly above a volcanic vent that slowly leaks carbon dioxide (CO_2) into the lake through the basin floor. In most lakes such gas bubbles would merely rise to the top. However, the high pressure and cold temperature

of the undisturbed bottom layer of Lake Monoun allowed the dissolved CO₂ to linger for years. As the concentration of carbon dioxide increased, it slowly approached a catastrophic tipping point.

During that deadly evening in 1984, something stirred the water at the bottom of Lake Monoun—possibly seismic activity, a landslide, or rainfall. Whatever the cause, some of the supersaturated layer was nudged up from the bottom and allowed to mingle with warmer, lower-pressure waters.

Although the temperature and pressure differences were only slight, the carbon dioxide crossed a critical threshold where it would no longer remain dissolved. One or more pockets of CO₂ abruptly expanded into their gaseous state. These bubbles then acted as nucleation sites, causing surrounding water to give up its trapped gases as well. When these large bubbles raced toward the lake surface, their suction force drew more of the stagnant water up into the lower-pressure area, liberating even more CO₂, and triggering a runaway chain reaction.

Hundreds of thousands of tons of captive gas were belched from the depths of the lake in a matter of moments, blowing the top off the lake with tremendous force. The displaced water created a tsunami of sorts as the upper layers of the lake surged over the shores. The escaped mass—made up of carbon dioxide, carbon monoxide, and traces of hydrochloric acid—was heavier than the surrounding air, causing it to cling to the earth and slither down the valleys of Cameroon. The river of toxic gas was mostly invisible, with occasional patches of white

mist. Almost everyone in its path was asphyxiated inside of a few minutes, although a handful fled to safety after watching their neighbors collapse, and a fortunate few were in elevated locations. Over the next few days, the lake gradually took on a red-brown tinge as the iron-rich water brought up from the deep was oxidized by the atmosphere.

The exploding-lake phenomenon, which had never been observed before then, came to be known

as a limnic eruption. The effect is roughly analogous to an exploding soda-pop bottle: When shaken, the small pocket of carbon dioxide at the top of the soda-pop container is distributed into the liquid as bubbles. If one then decreases the pressure by opening the lid, these bubbles provide substantial nucleation sites and the drink's carbon dioxide expands rapidly into a foamy mess.

Almost exactly two years after the mysterious eruption, sometime during the night on August 21, 1986, another of Cameroon's lakes exploded without warning. Lake Nyos, body of water with features quite similar to those of Lake Monoun, let loose its own dense cloud of deadly gas. While the Monoun explosion was tragic, its death toll was dwarfed by the devastation of the second incident. Lake Nyos expelled over a million tons of gas—about a cubic kilometer—and the heavy cloud engulfed a populated valley. Villagers began to feel profoundly ill, gasping for air but unable to get any oxygen. Some 4,000 people saved their own lives by fleeing from the valley. Many of them suffered respiration problems that lingered for days. Of the 1,800 or so who were unable to escape the toxic cloud, only a few survived. Joseph Nkwain, a survivor from the



■ Lake Nyos: scenic, serene, and sometimes genocidal.



■ Survivors of the Lake Nyos explosion await treatment at a hospital in northern Cameroon.

village of Subum, described his experience in a 1999 interview:

"I heard my daughter snoring in a terrible way, very abnormal... When crossing to my daughter's bed... I collapsed and fell. I was there till nine o'clock in the morning... until a friend of mine came and knocked at my door... I opened the door... I wanted to speak, my breath would not come out... My daughter was already dead... I went into my daughter's bed, thinking that she was still sleeping. I slept till it was 4:30 p.m. in the afternoon... on Friday. (Then) I managed to go over to my neighbors' houses. They were all dead."

The exact death toll was uncertain, but nearly every human and animal within a 15-mile radius perished. This included between 1,700 and 1,800 people, about 3,500 head of livestock, and massive amounts of wildlife. Investigators observed that Lake Nyos became reddish-brown over the following few days, just as Lake Monoun had done two years earlier. In addition, all vegetation on the

lake's shores had been mysteriously flattened, as if from an explosion.

Before the Lake Nyos eruption, scientists had still been uncertain regarding the cause of the 1984 deaths, but this second event clearly indicated that violent outgassings were to blame. Analysis of the lake confirmed that it was supersaturated with carbon dioxide, even in the aftermath of the eruption. In fact, the scientists estimated that the event had only released about 2 percent of the total dissolved gas in Lake Nyos. Meanwhile, the vents on the lake bottom are

continuing to charge the water with CO₂. Without intervention, the lake could erupt again in as little as a few years.

Since then, the much larger Lake Kivu in Rwanda has also been identified as a likely site of periodic outgassings. Its waters contain a much higher than normal concentration of dissolved CO₂ and methane, and fossil evidence indicates a massive biological die-off around the lake every 1,000 years or so. Due to the geography of Lake Kivu and the dense population along its shores, a limnic eruption there would likely result in the deaths of about two million people.

Today, sets of large polyethylene pipes constantly siphon the CO₂-laden water from the bottoms of lakes Monoun and Nyos, producing carbonated geysers on each lake's surface. However, according to a 2005 report by the U.S. Geological Survey, these scant few pipes are insufficient, and the treacherous lakes will not be safe anytime soon. At present levels of gas concentration, a new eruption could occur at either lake at any time, without warning.



THE FAREWELL DOSSIER

When the U.S. uncovers Soviet spies, they decide to give them exactly what they want

In 1982 operatives from the USSR's Committee for State Security—known internationally as the KGB—were desperately seeking an elusive bit of Western technology. The Soviets were constructing a highly lucrative natural gas pipeline across the expanse of Siberia, but they lacked the sophisticated software to manage the complex network of pumps, valves, turbines, and storage facilities that the system would require. Throughout the Cold War Soviet scientists had proven themselves adept at engineering feats such as space flight, but they had fallen behind America in computer technology and microelectronics. The United States government was understandably unwilling to sell the software to their Cold War adversary, and although a few other developed countries possessed the technical know-how, the U.S. used its considerable influence to prevent any other government from offering software assistance. The Russians, it seemed, had reached an impasse.

KGB officials, unconcerned with the trifles of international law, located a Canadian firm with access to the sought-after software and arranged to embed a KGB agent there. The Soviet spies successfully abducted the technology, but that particular copy of the pilfered program contained a few extra lines of computer code that had been inserted just for them.

About a year earlier, at a conference in Ottawa, French President François Mitterrand took U.S. President Ronald Reagan aside to share some intriguing information. Mitterrand explained that his government had obtained secret Soviet documents that detailed the penetration of KGB spies into U.S. industries, and he wanted to share the information with U.S. intelligence agencies.

The source of these documents was Colonel Vladimir I. Vetrov of the KGB's Directorate T, a department dedicated to the acquisition of Western technology. The 53-year-old engineer was responsible for evaluating the intelligence procured by the department's Line X field agents. The colonel secretly defected in 1980 after becoming disillusioned with the Communist ideal and began smuggling copies of Directorate T documents to French agents. The French assigned their double-agent the code name "Farewell."

As members of the U.S. Central Intelligence Agency began to receive and digest these documents, it became abundantly clear that the KGB was filling the gaps in its computer technology by

employing a vast network of professional infiltrators. The "Farewell" documents showed that the dastardly Directorate T had inserted hundreds of Line X operatives into visiting delegations during President Nixon's "diplomacy and cooperation" phase in the early 1970s. In one instance, Soviet scientists on a visit to Boeing had secretly applied adhesive to the bottom of their shoes, allowing them to covertly collect metal samples from the floor. The documents also indicated that one of the Soviet cosmonauts working on the joint U.S.-Russian *Apollo-Soyuz* spacecraft project was actually a KGB operative.

In all, Colonel Vetrov provided approximately 4,000 documents to the French that exposed an astonishing degree of Soviet subterfuge. The Americans discovered, much to their chagrin, that they had not been engaged in a true technology race with the Soviet Union; rather, the U.S. researchers had been constantly attempting to outdo themselves as the cunning KGB pilfered the progress. The defector's documents detailed all of the technologies the Soviets were seeking, consisting primarily of radar, computers, machine tools, and semiconductors. By all evidence, the Line X agents had already fulfilled over two thirds of the requirements.

The "Farewell" documents showed that the dastardly Directorate T had inserted hundreds of Line X operatives into visiting delegations during President Nixon's "diplomacy and cooperation" phase in the early 1970s.

Rather than arranging immediate deportation of the 200-plus KGB agents named in the "Farewell" intelligence, CIA officials seized the opportunity

to carry out some counterintelligence. The agency used Vetrov's documents to assemble a list of the technologies that Directorate T was still seeking, and worked in concert with the U.S. Defense Department and the FBI to bait Line X operatives with deliberately defective information. Agents planted inaccurate yet convincing plans for stealth aircraft, space shuttles, machine parts, and chemicals throughout U.S. industry, at any location where KGB agents were likely to stumble upon them. Over several months the polluted intelligence found its way into Soviet manufacturing and military, causing problems to arise in tractor factories, chemical production, and aircraft research.

In 1982 a fresh batch of Farewell documents revealed the USSR's plans to purloin the pipeline control software. CIA agents hastily programmed a special one-off version for the Soviets, and planted it at their target company in Canada. The KGB leadership was delighted at the ease of procuring the program, and it was handed off to the engineers for integration into their shiny new trans-Siberian pipeline. When they completed the system and engaged the power, everything seemed to go well. By spring of 1982 the Russians were milking the massive Urengoi natural gas field in Siberia and piping the fuel across Kazakhstan and Russia to Eastern Europe. The profit was tidy, and the going was good.

A few months later, as the pipeline hummed along in the Siberian summertime, the CIA's contribution to the control program asserted itself. Disguised as an automated system test, the software instructed a series of valves, turbines, and pumps to increase the pipeline's pressure well beyond the maximum safe capacity. This caused considerable and prolonged strain on the line's many joints and welds. Finally, somewhere in the vast loneliness of Siberia, the overexerted fuel pipeline succumbed to the pressure.

As satellites for the North American Aerospace Defense Command (NORAD) watched from orbit, a spectacular explosion rocked the Siberian wil-



■ Little did these construction workers know that the pipeline they were so carefully building would soon explode.

derness. The fireball had an estimated destructive power of three kilotons, or about a quarter the strength of the Hiroshima bomb. Initially NORAD suspected a small-yield nuclear test, but there was only silence from the satellites designed to detect the telltale electromagnetic signature. Most U.S. military officials were unaware of the Farewell dossier, and they were understandably concerned to see such a demonstration of power—one of the largest nonnuclear blasts ever recorded—occur in Siberia. But the CIA quietly assured them that there was nothing to worry about.

It was impossible for the CIA to predict which section of the pipeline would fail once its Trojan horse released its payload, but fortunately the failure occurred in a remote location. The explosion was massive and a large section of pipeline was left in ruin, but there were no casualties reported. The Soviet economy, however, was severely injured by the blast. When investigators in the USSR eventually discovered that the event had been triggered by sabotaged software, the KGB leadership was furious. Of course they were unable to lodge any official protest regarding the deliberate defect since that would imperil their own insidious espionage efforts.

Colonel Vladimir I. Vetrov continued to relay vital information to French intelligence officials for

well over a year. Then, in January 1982, the information channel fell silent. Later the U.S. learned that the colonel had been strolling through a park in Moscow when he stabbed a fellow KGB operative and another woman for reasons unknown. The ensuing police investigation exposed his treason, and he was executed for his crimes against the state on February 23, 1985.

The following year, as the Soviet economy struggled to recover, the United States and NATO dealt a further blow to the USSR by executing a mass deportation of all the Line X agents named in the Farewell dossier. With their U.S. and European spy network in shambles, the Russian's giant technology espionage machine ground to a halt.

The documents regarding the CIA's Farewell disinformation campaign were declassified in 1996, finally revealing the truth about the massive Siberian pipeline explosion 14 years after it happened. The long-running orchestra of subterfuge was one of the most successful U.S. interagency efforts ever undertaken. Some condemn the sabotage as thinly veiled terrorism given the lack of an open war with the Soviet Union, while others insist that ill-gotten goods are the plunderer's problem. In any case, it clearly demonstrates that software piracy can have very serious consequences.



THE FARTISTE OF PARIS

The greatest performers are full of hot air



Joseph Pujol, a man of singular talent, was born in Marseilles, France, in 1857. In his early youth it became clear that he was a natural entertainer, singing, dancing, and performing for his parents' house guests. He had a love of music, and over the years he became handy with a trombone, but it was a different wind instrument that led to his eventual fame and fortune.

Young Joseph became alarmed one day when he was swimming in the sea, and took a deep breath before submerging. As he inhaled, he felt icy cold water entering through his rear end. He immediately returned to shore, and was astonished to see a great deal of seawater pouring from his backside. When he consulted a doctor, the physician assured him that this was nothing to be concerned about. Joseph took this advice to heart, exploring his strange new ability with a healthy curiosity.

He soon found that a bit of abdominal control allowed him to deliberately suck water in through his anus and project it back out with impressive force, creating a spout of several meters. Further experimentation led him to discover that he could also suck in large amounts of air if he contorted himself properly, which he could project back out at will. With an artists' flair, he developed the ability to produce distinct notes by using varying force, allowing him to play simple tunes. Needless to say, this unorthodox music box helped

him to become very popular at school. But little did he know that this unique talent would one day make him the most well-known and most highly paid entertainer in all of France.

While Joseph was in the French army, he amused his fellow soldiers with his lowbrow tricks. They gave him the nickname "Le Pétomane," which translates roughly to "fartiste." When he left the service he opened a bakery in Marseilles that was reputed to bake some of the finest bran muffins in the South of France,

but when he began to feel restless, he started a foray into show business.

He did impressions of famous people, he played songs, and he blew out candles.

At first he resisted using his unique physiology in his stage comedy act, instead trying the "yokel with the trombone" routine, but the fartiste within him could not be contained.

In 1887, at age 30, Le Pétomane first took the stage in Marseilles. His initial attempt was met with some skepticism, since "pétomanie" (or "fartistry") was something of a novelty for the French. But he quickly won the audience over and was a big

success. He developed his act locally for about five years, before going on to Paris to try his luck at the infamous Moulin Rouge.

"Ladies and gentlemen, I have the honor to present a session of pétomanie." Such was his introduction at the famous vanity theater on his first night. He was very finely dressed in a red coat and black satin breeches, with a pair of white gloves held in his hands. He looked quite sophisticated as he explained to the audience that the emissions he was about to produce were completely odorless, since he irrigated his colon daily. The audience was completely unprepared for what lay ahead. And so he began.

He started off with a series of fart impressions: a new bride's timid toot; her noisy, flapping emissions a week later; the solid, booming fart of a miller; and a majestic, ten-second-long helping of flatulence to wrap up his introduction. He did impressions of famous people, he played songs, and he blew out candles. He did imitations of cannon fire and reenacted a thunderstorm. And that was just his first act.

Initially, the audience was astonished at the bizarre spectacle and uncertain how to respond. But when the first uncontrollable laughter erupted from the crowd, it quickly spread. Soon the men



■ Joseph Pujol was a manufacturer and purveyor of laughing gas.

and women in the audience were completely paralyzed with laughter, and there was nary a dry cheek or a straight face in the theater. As Le Pétomane's unconventional showcase continued, a number of semiconscious women had to be escorted from the theater by nurses; they had passed out from laughter, unable to breathe properly in their tightly bound corsets.

For the second part of his act, he stepped off-stage and inserted a rubber tube into his orifice. It dangled in an absurd fashion from a hole in the back of his trousers. He used this tube to smoke two cigarettes at once, one from each end, and to blow out the flames of stage lights. As a grand finale, he attached a flutelike instrument to the end of the hose and played popular tunes while inviting the audience to sing along.

Overnight, Le Pétomane was a huge success. He performed in this way for years, eventually becoming the highest-paid entertainer in all of France, and perhaps the world. In 1895, the owner of the Moulin Rouge sued him for breach of contract after he fart-serenaded a few people in public, so he parted ways with the famous theater to open his own. But he was quickly replaced by a female, bellows-powered fraud . . . La Femme-Pétomane.

Joseph enjoyed many more years of success at his own theater. But in 1914, two of his sons were disabled while serving in the Great War. At that point

he gave up the stage and went back to baking, leaving his rectum to content itself with more conventional pursuits.

Though Le Pétomane was perhaps the most famous fartiste in history, he was not the first to ply the farting trade; professional flatulism has a long and rich history throughout the world. In the *De Civitate Dei*,

written about halfway through the fifth century A.D., Saint Augustine mentions some performers who possessed "such command of their bowels, that they can

break wind continuously at will, so as to produce the effect of singing." As other examples, medieval Ireland had professional farters called "braigetor," and the Japanese Kamakura period (1185–1333) had fart dance performers called Oribe.

A contemporary flatulist, perhaps the only representative of his trade today, is Mr. Methane. He clearly lacks Le Pétomane's panache, but he can certainly break a wind. He resembles a superhero (or supervillain) in his bright green cape and mask, though whether the force of his farts is sufficient to allow him flight is doubtful.

As for Le Pétomane himself, he died in 1945, aged 88 years. When a medical school in Paris requested the privilege of examining the late Le Pétomane's famous anus, the family declined, stating, "There are some things in this life which simply must be treated with reverence."

Le Pétomane eventually became the highest-paid entertainer in all of France.

FART FACTS

The primary ingredients of a fart (nitrogen, hydrogen, carbon dioxide, oxygen, and methane) are all odorless. The distinct scent of flatulence is caused by trace amounts of bacterial by-products such as skatole, indole, and sulfur compounds.

- The reason for beans' famous fart-promoting properties is their high concentration of oligosaccharides. The human digestive system is unable to crack these bulky sugar molecules, so they pass into the large intestine unmolested. There, an army of gut bacteria feast on the sugary bean mash, and their millions of microscopic emissions merge into macrofarts. These carbohydrates are also present in other gas-producing foods such cabbage, peas, and onions.
- Farts may be a substantial contributor to global climate change. Methane is a potent greenhouse gas, and according to the U.S. Environmental Protection agency, about 21 percent of the atmosphere's human-related methane is emitted by livestock belches and farts. About 11 percent of the atmosphere's naturally occurring methane comes from the farts of termites.
- Termites can channel the power of flatulence as a defensive mechanism. When confronted with an intruder, a worker termite can break wind so violently that their abdomen explodes, spewing feces and noxious chemicals onto their enemies. These tiny suicide farters sacrifice their lives for the good of the colony.
- Paleontologists have actually discovered fossilized farts. Prehistoric insects frequently became mired in tree sap and would break wind during their efforts to escape. The sap then hardened into amber, preserving the unfortunate insect and the tiny bubbles of its final struggle.
- High Altitude Flatus Expulsion (HAFE) is caused when intestinal gases expand due to decreased atmospheric pressure, such as ascending a particularly tall mountain (11,000 feet or more). The spontaneous expansion of gut gases results in a gross increase in the volume and frequency of flatulence. Although considered a "significant inconvenience" for extreme mountain climbers, it is not hazardous to one's health.

A FLUKE OF NATURE

Parasites pass through coughing snails and zombie ants in order to find their final host

As the sun rises over a grassy pasture and the morning light glints from the countless clinging drops of dew, a single snail resolutely inches toward a mound of steaming nourishment. But unbeknownst to the armored gastropod, this seemingly ordinary heap of cow dung conceals a legion of tiny *Dicrocoelium dendriticum* (aka lancet fluke) eggs, each of which contains the embryo of a sinister mind-controlling parasite. As the snail gorges itself on the fibrous feast, it unwittingly sets an army of unborn flukes on a miniature adventure that will lead them through slime, zombies, and bile to ultimately find their own unique kind of utopia.

As the ingested eggs slide into the snail's belly, the moisture and digestive juices coat the wee ones from their shells. Propelled by the minuscule hairs that line their bodies, the infant flukes grope their way through the darkness to the hapless host's digestive gland. There they establish a makeshift home as they mature into tadpole-like adolescence.

Once they're ready to venture out on their own, the plucky young parasites leave the warm comfort of the snail gut. They make their way to their host's respiratory chamber, where they gather in by the hundreds along the inner wall and wait. Their presence tickles the inner lining of the breathing cavity, inciting the organ to coat the irritating invaders with a layer of thick mucus. When the slime-pearl reaches a sufficient size, the snail coughs it out, ejecting the sticky group of flukes out into the world. Lying there,

sealed in their moist, protective cocoon, the young parasites bide their time. The snail meanders off on its own, having suffered no harm aside from a particularly phlegmy cough.

A nearby ant that is foraging for food stumbles upon the slime ball in a bed of vegetation. The sweet snail-mucus pheromones present an irresistible treat for the ant, so it totes the treasure back to the colony. As the slime is savored by the insects, the clandestine flukes infiltrate the ants' anatomies. Most of the parasites make their way to the abdomen, but a few take a detour that leads them to the insect's nerve center, where they use mysterious methods to establish overpowering influence.

The next evening, as the armies of ants file back to their colony after a long day's work in the hot sun, those who partook of the sweet slime uncharacteristically break ranks and wander away in a daze. Acting out the demands

■ The lancet fluke is a parasite with multiple hosts.



Each dangling, stupefied ant-zombie remains paralyzed on its perch throughout the night.

of the unwelcome guests lodged in their heads, infected ants then penetrate the jungle of foliage and select a random blade of grass. They clamber up the long, thin leaf and crawl out to the tip, where they obey a powerful urge to secure themselves in position with their clam-like mandibles.

Each dangling, stupefied ant-zombie remains paralyzed on its perch throughout the night. Sometime after the light and warmth of dawn reappear, the compromised insect comes to its senses and climbs back down to return home. During the day it rejoins its working comrades as though nothing happened; but as evening approaches and temperatures cool, the parasitic flukes will once again urge their host to venture alone into the wilderness. A new blade of grass is selected and scaled, and the ant once again positions itself upon the tip. This bizarre modified existence continues until one day the dangling insect is sucked into the jaws of

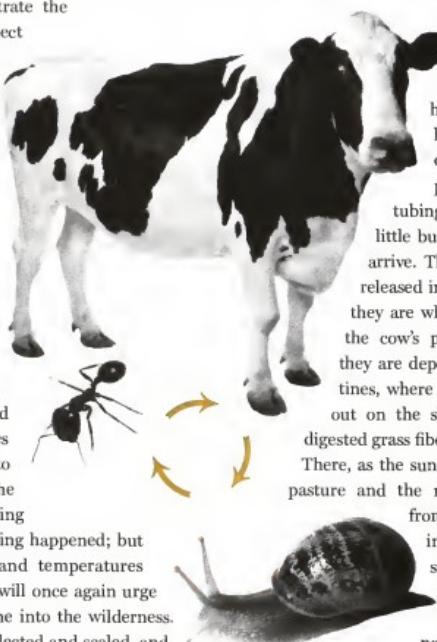
a beast. Perhaps a grazing cow (or sheep or goat) plucks the occupied grass from the ground during its dawn or dusk feeding, oblivious to the zombie ant and its evil masters.

Once the fluke warriors have succeeded in entering this, their final quarry, they burst from their Trojan ant and use their mighty tails to swim through the maze of organs. Eventually they arrive at the quiet suburbia of cow guts—the bile duct—

where the well-traveled adults settle down and abandon their host-hopping ways. The lancet flukes live in quiet parasitic happiness within the wet

tubing, and before long the little bundles of joy begin to arrive. The mothers' eggs are released into the bile duct, and they are whisked along through the cow's plumbing. Eventually they are deposited into the intestines, where the eggs hitch a ride out on the slow-moving train of digested grass fibers.

There, as the sun rises over the grassy pasture and the morning light glints from the countless clinging drops of dew, a single snail resolutely inches toward a mound of steaming nourishment.



■ Lancet fluke life cycle: from cow dung to snail lung to ant brain to cow stomach—and then all over again.

THE FORDLÂNDIA FIASCO

Henry Ford's failed attempt at rubber-barony

In the early 20th century, a cartel of Dutch and English rubber barons had a stranglehold on the world's supply of rubber. At that time the sole source of rubber was the South American tree *Hevea brasiliensis*, whose sap is natural latex. In the 1870s a gaggle of entrepreneurial smugglers had secreted a stash of wild rubber tree seeds out of the Amazon rain forest, which they used to establish sprawling plantations in East Asia. These outpaced the output of Brazil, eventually causing their owners to enjoy the majority of the world's rubber business.

But by the late 1920s, the infamous automobile tycoon Henry Ford set out to break the back of this rubbery monopoly. His hundreds of thousands of new cars needed millions of tires, which were very expensive to produce when buying raw materials from the established rubber lords. To that end, he established Fordlândia, a tiny piece of America that was transplanted into the Amazon rain forest for a single purpose: to create the largest rubber plantation on the planet. Though enormously ambitious, the project was ultimately a fantastic failure.

In 1929, Ford hired a native Brazilian named Villares to survey the Amazon for a suitable location to host the massive undertaking. Brazil seemed the ideal choice, considering that the trees in question were native to the region and the rubber harvest could be shipped to the tire factories in the U.S. by land rather than sea. On Villares' advice, Ford purchased a 25,000-square-kilometer tract of land along the Amazon River and



■ Aspiring rubber baron Henry Ford and his son Edsel.

immediately began to develop the area. Workers started erecting a rubber-processing plant as the surrounding area was razed of vegetation.

Scores of Ford employees were relocated to the site, and over the first few months an American-as-apple-pie community sprang up from what was

once a jungle wilderness. It included a power plant, modern hospital, library, golf course, hotel, and rows of white clapboard houses with wicker patio furniture. As the town's population grew, all manner of businesses followed, including tailors, shops, bakeries, butcher shops, restaurants, and shoemakers. It grew into a thriving community with Model T Fords frequenting the neatly paved streets.

Outside of the residential area, long rows of freshly planted saplings soon dotted the landscape. Ford chose not to employ any botanists in the development of Fordlândia's rubber tree fields, instead relying on the cleverness of company engineers. Having no prior knowledge of rubber-raising, the engineers made their best guesses and planted about 200 trees per acre. The plantations of East Asia were packed with flourishing trees, so it seemed reasonable to assume that the trees' native land would be just as accommodating.

Henry Ford's miniature America in the jungle attracted a slew of workers. Local laborers were offered a wage of 37 cents a day to work on the fields of Fordlândia, which was about double the normal rate for that line of work.

Ford's effort to transplant America was not limited to American-style buildings—it also included mandatory "American" lifestyle and values. The plantation's cafeterias were self-serve, which was not the local custom, and they provided only American fare, such as hamburgers. Brazilian laborers had to live in American-style houses and they were required to attend squeaky-clean American festivities on weekends such as poetry readings, square-dancing, and English-language sing-alongs.

One of the more jarring cultural differences was Henry Ford's mini-prohibition. Alcohol was strictly forbidden inside Fordlândia, even within the workers' homes. This led some industrious locals to establish businesses-of-ill-repute beyond the outskirts of town, allowing workers to exchange their generous pay for the comforts of rum and women.

While the community struggled along month to month with its disgruntled workforce, it was also faced with a rubber dilemma. The tiny saplings weren't growing at all. The hilly terrain hemorrhaged all of its topsoil, leaving infertile, rocky soil behind. The few trees that were able to survive into arbor adolescence were soon stricken with a leaf blight that ate away the leaves and left the trees stunted and useless. Ford's managers battled the fungus heroically, but they were not armed with the necessary knowledge of horticulture.

Workers' discontent grew as the unproductive months passed. Brazilian workers—accustomed to working before sunrise and after sunset to avoid the heat of the day—were forced to work proper "American" nine-to-five shifts under the hot Amazon sun, using Ford's assembly-line philosophies. In addition, malaria became a serious problem owing to the hilly terrain's tendency to pool water, providing the perfect breeding ground for mosquitoes.

Ford chose not to employ any botanists in the development of Fordlândia's rubber tree fields, instead relying on the cleverness of company engineers.

In December 1930, after about a year of working in a harsh environment with a strict and disagreeable "healthy lifestyle," the laborers' agitation reached a critical mass in the workers' cafeteria. Having suffered one too many episodes of indigestion and degradation, a Brazilian man stood and shouted that he would no longer tolerate the conditions. A chorus of voices joined his, and the cacophony was soon joined by an orchestra of banging cups and shattering dishes. Members of Fordlândia's American management fled swiftly to their homes or into the woods, some of them chased by machete-wield-



■ The factories of Fordlândia still stand, despite having been long ago abandoned.

ing workers. A group of managers scrambled to the docks and boarded the boats there, which they moved to the center of the river and out of reach of the escalating riots.

By the time the Brazilian military arrived three days later, the rioters had spent most of their anger. Windows were broken and trucks overturned, but Fordlândia survived. Work resumed shortly, though the rubber situation did not improve. A British journalist writing for the *Indian Rubber Journal* visited in 1931 and wrote, "In a long history of tropical agriculture, never has such a vast scheme been entered in such a lavish manner, and with so little to show for the money. Mr. Ford's scheme is doomed to failure."

The intervening months offered little evidence to counter the journalist's grim depiction. In 1933, after three years with no appreciable quantity of rubber to show for the investment, Henry Ford finally hired a botanist to assess the situation. The botanist tried to coax some fertile rubber trees from the pitiful soil, but he was ultimately forced to conclude that the land was simply unequal to the task. The damp, hilly terrain was terrible for the trees but excellent for the blight. Unfortunately no one had paid attention to the fact that the land's previous owner was a man named Villares—the same man Ford had hired to choose the plantation's site. It seems Henry Ford had been sold a lame portion of land.

Never one to surrender to circumstance, Ford purchased a new tract of land 50 miles downstream,

establishing the town of Belterra. It was more flat and less damp, making it much more suitable for the finicky rubber trees. He also imported some grafts from the East Asian plantations, where the trees had been bred for resistance to the leaf blight. For ten years Ford's workers labored to transform soil into rubber, yielding a peak output of 750 tons of latex in 1942—far short of that year's goal of 38,000 tons.

Ford's perseverance might have eventually paid off if it were not for the fact that scientists developed economical synthetic rubber just as Belterra was establishing itself. In 1945, Ford retired from the rubbering trade, having lost more than \$20 million in Brazil without ever having set foot there. A company press release announced the abandonment of Belterra with a bland epitaph: "Our war experience has taught us that synthetic rubber is superior to natural rubber for certain of our products." The Ford Motor Company sold the land back to the Brazilian government for \$250,000—a token sum.

Henry Ford's losses in Fordlândia and Belterra are equivalent to \$200 million in modern dollars. Certainly he was unable to buy his way into rubber royalty, and his efforts to spread his American "healthy lifestyle" were met with resentment and hostility . . . but history has repeatedly shown that obscene wealth gives one the privilege—perhaps even the obligation—to make bizarre and astonishing mistakes on a grand scale. From that perspective, Fordlândia could not have been more successful.

GELOTOLOGY 101

Anatomy of the best medicine

Within a nondescript university laboratory, a neurobiologist reads aloud from a list of prepared phrases. In the adjoining room, a volunteer listens attentively with a collection of colorful wires trailing from his head. The needles on the electroencephalograph (EEG) flutter with each utterance, but most of the phrases prompt little discernible reaction from the testee. Among the long list of experimental sentences, however, a few provoke a peculiar response. The volunteer's face muscles contract and his body begins to convulse. His breathing becomes spasmodic, and he emits a series of involuntary, repeated vocalizations. For one informative moment, the EEG's mechanical scribblers flap rapidly from margin to margin, providing a nugget of neurological gold.

The condition under study is surprisingly common among humans. Though the episodes are usually transitory, they will occasionally erupt as intense, prolonged outbursts where bodily fluid containment is placed in jeopardy as the hapless victim collapses into a moist, quivering, rhythmically vocalizing mass. The phenomenon is highly contagious, and in extreme cases, it can even lead to death. Taken together, these remarkable bizarre symptoms are known as *laughter*, and although it is universal among human races and cultures, its processes and purpose are not yet fully understood.

The formal study of laughter is conducted by specialists



■ *Serious testing on a humorous topic.*

known as gelotologists, and thanks to their EEGs, fMRI scans, stethoscopes, and sphygmomanometers, the physiology of laughter is well documented. First, the muscles of the face contract, baring the individual's upper teeth as they involuntarily evacuate the contents of their lungs. The diaphragm and abdominal muscles begin staccato spasms, while the larynx—which is squeezed halfway shut by the epiglottis—turns each spasm-segmented breath-burst into a short “ha!” vocalization. During particularly boisterous episodes, the tear ducts and sweat glands activate, and the body may experience a profound loss of muscle strength known as gelotolepsy. Additionally, the irregular breathing may produce gasps or snorts to punctuate the absurd spectacle. In spite of these involuntary physical effects, the experience is usually perceived as pleasant due to the opiate-like endorphins that simultaneously saturate the brain.

One peculiarity of laughter is that the mere sound of it can trigger similar gelotoleptic fits in others. Moreover, a person is 30 times more likely to laugh if there are other people present. These insights strongly suggest that the physical expression of laughter serves as a social signal among humans. But contrary to popular belief, laughter is not a uniquely human trait. When dogs and primates share positive social contact such as wrestling, play chasing, or touching, they often make laughterlike vocalizations, and ultrasonic laughter has been recorded during groundbreaking rat-tickling experiments. In each case, the sound of laughter seems to reduce stress levels and promote bonding among the animals. Considering the participation of the brain's reward centers, it is likely that laughter provided humanity's precursors with some important survival advantage. The brain has evolved to reward important activities with a burst of endorphins, thereby enticing the individual to repeat the action frequently. The bliss found in eating fatty foods, for instance, provided early humans with the ambition to hunt and devour energy-rich

animal flesh. Sexual intercourse—another area of study which is mysterious and intriguing to scientists—also rewards the participants with a cocktail of natural feel-good biochemicals. Laughter, however, has no obvious survival-stimulating analog.

One prevailing theory states that humor is a learning mechanism to detect incongruence between expectations and reality. The brain is a powerful pattern-matching engine, maintaining a model of reality by storing the patterns it observes and sorting them in order of importance. From one moment to the next, the river of incoming sensory information is scanned for similarities to prior patterns, and extra attention is given to A) anything that strongly matches an important stored pattern, such as a familiar face; and B) patterns that are atypical in the present context, such as a familiar face in bed with one's spouse.

Essentially, the incongruence theory of humor suggests that an event registers as “funny” when it starts out by conforming to established patterns but then defies the person's model of reality by taking an unanticipated (but logically valid) detour. In a similar way, humor can occur when a nonsensical sequence suddenly reveals an underlying coherence, a method frequently used in joke punch lines:

A: *“Did you hear the one about that series of illogical events that occurred involving a duck? They turned out to be congruent in some unexpected way?”*

B: *“Har, har! Please excuse me while I breathe spasmodically and become moist!”*

According to this theory, the endorphin payoff encourages the brain to learn by seeking out and storing new logical patterns, such as those revealed in jokes, puns, syllable-transposing spoonerisms (“bowel feast” instead of “foul beast”), and Freudian sluts . . . er, slips. Laughing aloud encourages other members of the social group to notice the unexpected congruence. Once the new pattern is incorporated into the psyche, subsequent exposures



■ A human subject demonstrates a boisterous guffaw.

to similar patterns will not be surprising, which explains why jokes are only funny the first time around. The incongruity theory also suggests that humor is a demonstration of one's intelligence and problem-solving proficiency, and therefore laughing at someone is belittling due to the implication of intellectual inferiority.

John Morreall, the founder of the hardly-ever-dull International Society for Humor Studies (ISHS), offers a competing but possibly partially compatible theory. His hypothesis posits that the biological origin of laughter is a shared expression of relief at the passing of danger. In his model, endorphines serve to suppress the biological fight-or-flight response as well as promoting bonding among a group that works together to overcome a stressful situation. The vocalizations send a message that the risk of danger has passed. According to this stress-centric

theory, a joke is funny when the setup creates a psychological crisis of interpretation and the punch line reveals that there is no real threat.

Laughter's tendency to appear during times of stress was accidentally illustrated by Dr. Stanley Milgram's infamous obedience experiments of 1961. In these tests, volunteers dubbed "teachers" were instructed to administer electric shocks to a "learner" in a neighboring room. Unbeknownst to the teachers, the learner was an actor, and the shock controls were merely a convincing fabrication. At the experimenter's insistence, the teachers toggled the shock controls each time the "learner" answered a question incorrectly, progressively intensifying the shock power as the learner howled about chest pains and heart trouble. Some "teacher" volunteers refused to continue after delivering a few mock shocks, but most were strangely complicit in spite of their discernible distress. About one third of the flustered volunteers exhibited hysterical laughter during the experiment, as described by Milgram in his report:

“The laughter seemed entirely out of place, even bizarre. Full-blown, uncontrollable seizures were observed for three subjects. On one occasion we observed a seizure so violently convulsive that it was necessary to call a halt to the experiment. The subject, a 46-year-old encyclopedia salesman, was seriously embarrassed by his untoward and uncontrollable behavior. In the postexperimental interviews, subjects took pains to point out that they were not sadistic types and that the laughter did not mean they enjoyed shocking the victim.”

Stress may have also played a role in one of the most anomalous and dramatic episodes of laugh-

ter in recorded history. In 1962, in the small village of Kashasha, Tanganyika (modern Tanzania), a group of students at a boarding school began to snicker following some remark or event that is now lost to history. For reasons unknown, the laughter was abnormally infectious, and soon the greater part of the student body was incapacitated with the contagious convulsions. In an effort to quell the inexplicable outbreak, administrators closed the school and sent the giggling students home, but this allowed the epidemic to spread. Parents, siblings, and neighbors were reduced to wriggling, vocalizing masses, and the Tanganyika Laughter Epidemic rapidly propagated to thousands of people, including other schools, workplaces, and a neighboring village. Over time the sporadic, recurring lapses into laughter began to cause abdominal pain, fainting, respiratory problems, rashes, and uncontrollable weeping in some individuals. Reports vary regarding the duration of the epidemic—spanning anywhere from 6 to 18 months—but over time it naturally faded. Most historians and scientists attribute the bizarre incident to mass hysteria. The nation had won its independence from Britain only months prior, and the transition may have produced unusually high levels of stress among the citizenry.

Dr. Robert R. Provine, a behavioral neurobiologist at the University of Maryland-Baltimore County (UMBC), spent a decade conducting “urban safari” eavesdropping experiments to observe laughter in the wild. He and his team discreetly monitored

more than 2,000 instances of naturally occurring laughter in public places and was surprised to discover that it was very rarely connected to humor. People often laughed about mundane remarks such as “Hey, John, where ya been?,” “How did you do on the test?,” and “That guy in the white lab coat has been staring at us for a while.” The study showed that such conversational laughter seldom interrupts sentence structure, instead punctuating speech when one would normally pause or breathe. Speakers were also seen laughing more often than their audiences—about 46 percent more often when the speaker was male, and 126 percent more with females. The human brain, it seems, capitalizes on the bonding element of laughter to reflexively lubricate everyday communication.

Although laughter tends to disappear when it is placed under scrutiny, researchers



■ "My stars, that's ever so whimsical!"

have managed to catalog some of the mechanisms that drive it. For instance, it has been noted that individuals who suffer damage to their right frontal lobe often lose their ability to appreciate traditional humor, though they still laugh at slapstick and socially inappropriate jokes. In 1998 Dr. Itzhak Fried at UCLA discovered that some laughter circuits route through the left frontal lobe as well. He was conducting some electrical stimulation of a teenage girl’s brain in an effort to find the source of her epileptic seizures. As he probed, the young woman abruptly began to smile and giggle. Flummoxed, the researcher asked what she found so humorous. “You guys are just so funny—stand-

ing around," she explained. Moments later she laughed again, this time attributing the amusement to an inconspicuous photograph hanging on the wall. It soon became clear that any prodding of a particular patch of her left frontal lobe resulted in laughter, and each time she assigned blame to whatever happened to be in her field of vision. In the interest of science, Fried increased the current slightly and noted a marked increase in guffaw intensity. Another notch, and his patient gushed unrestrained waves of exuberant laughter.

Aside from the occasional discomfort, unconsciousness, or death, laughter's health effects on the human body are largely positive. It has been implicated in improving the health of the heart, immune system, and muscles, and it increases tolerance for pain. Ongoing studies also suggest that frequent laughter reduces the likelihood of strokes and reduces blood sugar levels in people with diabetes. Additionally, the accelerated breathing that accompanies laughter produces elevated amounts of carbon dioxide, which is beneficial for plant life.

Whatever its physiological mechanism may be, one of the fascinating facets of laughter is humanity's eagerness to incite it. People happily pay significant sums of money to have other people utter incongruent things at them, all in the hopes that it will trigger the spasmodic-breathing, epiglottis-squeezing, involuntary vocalizations of pure primitive pleasure. But curiously, many of these selfsame endorphin junkies frown upon other professions that strive for the same chemical-reward ends. Humans are indeed a strange and inconsistent species.

OVERDOSING ON HILARITY

Laughter is a frequent trigger of asthma attacks, and in some individuals it can cause syncope, or loss of consciousness. Additionally, on at least three verifiable occasions, laughter has triggered a state of sharply reduced animation known as death:

England, 1975: Fifty-year-old bricklayer Alex Mitchell died while watching the television show *The Goodies*. The episode depicted a kilt-clad Scotsman using his bagpipe to deflect a vicious black pudding intent upon attacking him. After 25 minutes of uproarious laughter, he died of heart failure as his wife watched helplessly. She later penned a letter to the *Goodies*, thanking them for making her husband's final moments so pleasant.

Denmark, 1989: Hearing-aid-maker Ole Bentzen died while watching *A Fish Called Wanda*. During a scene featuring John Cleese, Bentzen began laughing so hard that he was seized by a heart attack and died.

Thailand, 2003: Fifty-two-year-old ice-cream salesman Damnoen Saen-um awoke his wife when he began laughing boisterously in his sleep. She was unable to rouse him, and he died after two minutes of continuous laughter, presumably of heart failure or asphyxiation.

THE GIMLI GLIDER

A Boeing 767 with 61 passengers on board loses all power at 41,000 feet

Holy shit." Inside the cockpit of the cruising airliner, Captain Bob Pearson was understandably alarmed by the unusual beeps that were chiming from his flight computer. On the control panel, an amber low-fuel-pressure warning lamp lit up to punctuate the audio alarm.

First Officer Maurice Quintal, copilot of Air Canada Flight 143, checked the indicator light to determine the cause of the computer's complaints. "Something's wrong with the fuel pump," he reported.

The mustachioed Captain Pearson pulled out the trusty Boeing handbook, his fingers dashing through the pages to find the specifics of the warning. To his relief, the troubleshooting chart indicated that the situation was not as perilous as it might seem: The fuel pump in the left-wing tank was signaling a problem, a minor issue considering that gravity would continue to feed the engines even if the pump failed.

"You know," he commented to copilot Quintal, "I would not take this air-..." He trailed off as the computer blurted out another four beeps and the indicator panel lit up like a Christmas tree decorated with bad news. "Oh, f***k," Pearson lamented, "we've got to go to Winnipeg."

The date was July 23, 1983, and although the fuel-pressure warning was not the flight's first mechanical issue, it was certainly the most distressing so far. When pilots Pearson and Quintal arrived for their shift earlier that day, they were notified that the plane's fuel gauges were nonfunctional due to a fault in the Fuel Quantity Indicator System (FQIS). Even worse, the part required to repair it could not be delivered until later that evening.

Rather than canceling the flight, Captain Pearson instructed the engineers to check the fuel level manually. The four-month-old 767 was a state-of-the-art machine with state-of-the-art glitches, and FQIS issues were becoming a common complaint. Several independent dripstick checks later, the fuel hoppers were satisfied that sufficient fuel was loaded, and they advised Air Canada Flight 143 to take off. The airliner departed from Montreal at 5:48 P.M. eastern time with its 61 passengers. At 6:58 P.M., it made a brief scheduled stopover in Ottawa, where engineers once again checked the fuel dripsticks—just to be safe.

It was just after 8 P.M. central time when the cockpit computer began its string of alarming beeps and warning lights. As the jumbo jet crossed the Canadian countryside at 41,000 feet, copilot Quintal thumbed through the 767 handbook to ascertain the nature of the airplane's problem. According to the computer's calculations, there should have been plenty of fuel remaining, but multiple fuel pumps were indicating pressure problems. The flummoxed flight crew decided to divert to the nearby Winnipeg airport as a precaution, and alerted Air Traffic Control (ATC) of their intent.

"Air Canada 143 cleared present position direct Winnipeg," the tower responded. "Air Canada 143, did you want any assistance?" the traffic controller inquired, "assistance" being an aeronautic euphe-

mism for a reception from the fire brigade.

"For the moment we won't require any assistance," Pearson responded.

A flight engineer who was onboard the plane joined the pilots in the cockpit and struggled to assess the situation. "You've got nothing in the center tanks, eh?" he inquired of the captain.

"No, we ran the pumps," the captain replied, referring to an earlier attempt to transfer fuel from another tank. "Uh, let's put them back on again." Within moments, several more warning lights snapped on in quick succession. "Holy shit."

"Goddamn," Quintal remarked, "they're all going out, eh? How about uh . . ."

"All the lights are on," Pearson observed soberly, as the array of low-fuel-pressure indicators glowed with incandescent urgency. The captain summoned the in-charge flight attendant to the cockpit and apprised him of the situation, but his summary of events became obsolete mere moments later. The flight computer bellowed out a flamboyant *BONG!* that none of the men present could recall having ever heard before.

The captain glanced over his instrument panel to determine the cause of the new alarm. "Okay," he observed, "we've lost the left engine."

"Okay, what . . . will we do?" Quintal replied. "Want the checklist now?"

"Checklist, yeah."

The pilots began preparations for a delicate but very doable single-engine landing, and copilot Quintal contacted Winnipeg tower to request the



■ One sound you don't want to hear at the controls of a 767: BONG!

previously offered "assistance." It was becoming increasingly clear that the plane's problems lay not in its machinery but in its fuel.

Following two minutes of uneventful descent, the ever-present vibrations in the deck were disrupted by an almost imperceptible shudder, and the white-noise hum of the remaining jet engine faded away with a long and melancholy mechanical sigh. The gauges and monitors of the control panel—which had been so animated with anxiety mere moments before—fell dark. An unsettling silence hung heavy in the air.

"How come I have no instruments?" Captain Pearson wondered aloud, though the answer lingered mockingly in the cockpit's uncharacteris-

tic quiet. With both engines stalled, there was no electricity for the computer and no power to manipulate the ailerons, rudder, and elevator. The highly advanced flying machine now had roughly the maneuverability of a brick, with barely enough instrumentation to monitor its slow dive toward earth. After a few ponderous moments, however, the automatic emergency systems twitched into action. Onboard batteries revived a few of the most critical instruments, and a door popped open on the plane's underbelly to expose a ram-air turbine (RAT) designed to provide limited emergency hydraulic support.

The highly advanced flying machine now had roughly the maneuverability of a brick, with barely enough instrumentation to monitor its slow dive toward earth.

"143," the radio crackled, "we have lost your transponder return right now."

Captain Pearson was beginning to grasp the true gravity of the situation. "Center, one-four-three, this is mayday, and we require a vector onto the closest available runway. We are out of 22,000 feet on . . . Both engines have failed due to looks like fuel starvation, and we are on emergency instruments and can only give you limited headings. Information—we are heading two-five-zero now, please give us a vector to the nearest runway."

"143, we copy all that okay. We have lost your transponder return and attempting to pick up your target now . . . we have it now, just stand by on the two-five-zero heading."

"Ah, roger."

After repeated unsuccessful attempts to restart the stalled engines, Pearson and Quintal once again consulted the 767 emergency manual, this time

searching for tips on executing an unpowered landing. Much to their dismay, no such section existed. Presumably a simultaneous engine failure had been too ridiculous for Boeing engineers to contemplate. The pilots sat anxiously in their darkened cockpit and monitored the plane's slow and silent descent using a handful of analog instruments based on pre-World War II technology: a magnetic compass, an artificial horizon, an airspeed indicator, and an altimeter.

The traffic controller in the tower at Winnipeg advised the flight officers of their options: "143, we show you at 65 miles from Winnipeg and approximately 45 miles from Gimli."

"Okay," Pearson responded, "is there emergency equipment at Gimli?"

"Negative emergency equipment at all. Just one runway available, I believe, and no control and no information on it."

"We'd prefer Winnipeg then."

As luck would have it, Captain Pearson was an accomplished glider pilot, a skill that afforded him a vague idea of how the 767 would behave without thrust. He applied his expertise to estimate the plane's best glide ratio speed, but having neither a vertical speed indicator nor a view of the landscape through the clouds, he was unaware that Winnipeg was well beyond the reach of their gravity-gripped flight equipment.

Back in the passenger compartment, the in-charge flight attendant radiated counterfeit calm as he informed the plane's 61 passengers of the situation and instructed them in the subtle art of not freaking out during an in-flight emergency. In the meantime, crew members directed able-bodied men to move into the rows alongside the exit doors, then solemnly buckled into their own seats. Many of the crew members were keenly aware that jumbo jets such as theirs were not designed for dead-stick flight let alone dead-stick landings. In all probability, their inevitable confrontation with the earth would not be an improvement on their current situation.

As the impromptu glider emerged from the ceiling of clouds and obtained a view of the landscape, the pilots realized quickly that the plane was shedding altitude far too quickly to have any chance of reaching Winnipeg. Copilot Quintal confirmed this conclusion using radar data from Air Traffic Control:

"How far are we from Gimli?" Pearson inquired of the Winnipeg tower.

"You are approximately 12 miles from Gimli right now."

Air Traffic Control had no specific data on the remote airstrip, but in another stroke of luck, First Officer Quintal had been stationed there during his time in the Royal Canadian Air Force. Lacking any feasible alternative, the copilot recommended they drop in on his old friends from the service. He

was not aware, however, that the facility had been converted into a public airport after he left the Air Force; nor did he know that one of its two runways had been decommissioned and carved up for use as an auto racetrack.

As Flight 143 fell below the Air Traffic Control radar range, the tower grimly requested a count of the souls on board. As Pearson began his long final approach, he scraped up a bit of optimism as he updated Winnipeg tower on their status. "We have the field in sight," he reported, "and we feel we're in good shape."

On the ground at Gimli, it was Family Day at the local racetrack. Sports racers buzzed along as spectators cheered from the sidelines. A collection of campers at the end of the airstrip soaked up the warm Saturday evening as their dinners sizzled

FORMS OF TERROR

One fine day in 1961, ten soldiers at Fort Hunter Liggett military base in California climbed aboard a small airplane for what they assumed would be a routine training mission. After several minutes of cruising over the sparkling Pacific, one of the plane's propellers sputtered then stalled. The fuselage pitched wildly to one side, and the aircraft began an unscheduled descent. The pilot grappled with the convulsing flight yoke for a few fruitless moments, then made an announcement over the PA: "We have an emergency," he explained. "An engine has stalled and the landing gear is not functioning. I'm going to attempt to ditch in the ocean. Please prepare yourself."

One of the plane's stewards, evidently a very organized individual, stumbled around the careening cabin distributing insurance forms and pencils. He explained that the information would be vital if the worst were to happen. The distracted soldiers hunched over their forms and struggled to untangle the complicated instructions. As each soldier completed the task, he handed in his form and braced for impact. Moments after the last soldier put down his pencil, however, the stalled engine miraculously restarted. The plane returned to base without further incident.

The emergency had been nothing more than a simulation devised by diabolical government scientists to measure the effects of "behavioral degradation under psychological stress." The insurance forms had been engineered to be particularly difficult to interpret. After reproducing the test multiple times, the researchers were able to confirm that fear of imminent death does indeed interfere with one's ability to fill out insurance forms. Unsurprisingly, the control groups on the ground made considerably fewer errors when completing the same paperwork.

on assorted barbecues. Without the noise of jet engines to announce the airliner's approach, the people were oblivious of the 132-ton Boeing behemoth bearing down on them.

In the cockpit, copilot Quintal activated the manual landing gear controls, and the two main gears lowered and locked. The nose gear, however, dangled limply from its housing. The flight controls were becoming increasingly difficult for Captain Pearson to operate. The power provided by the emergency RAT was directly proportional to the speed of the wind slipping around the fuselage, so as the plane gradually slowed, the hydraulic assistance was diminishing. Nevertheless, Pearson knew he must sharply reduce the speed and altitude of his approach, otherwise the 767 would overshoot the tarmac. And without engines, there would be no opportunity for a second try. Ordinarily a pilot would apply some combination of flaps and aerobrakes, but these systems were nonfunctional on the crippled craft.

Without the jet engines to announce the airliner's approach, the people were oblivious of the 132-ton Boeing behemoth bearing down on them.

Lacking a more orthodox option, Captain Pearson cranked the control wheel to the right and gave the left rudder pedal a firm stomp. The crisscrossed controls tilted the deck to the right as one wing dipped toward the ground, providing the passenger compartment with a lovely view of the golf course on one side and nothing but blue sky on the other. The fuselage also rotated its heading to the left, becoming diagonal relative to its direction of travel. Such forward-slip maneuvers were used frequently on small planes and gliders, but no

one had ever tried the curveball-like air acrobatics with a jumbo jet. The airplane indeed decelerated, but the reduced airspeed robbed the controls of even more precious hydraulic pressure, requiring Pearson to apply monumental force to try to straighten the slip.

At the opposite end of the runway, the Family Day campers and spectators had finally spotted the silent and oddly angled incoming aircraft. The men, women, and children scrambled from its path with appropriate levels of panic. First Officer Quintal caught sight of the fleeing families in the last few moments, but it was far too late to revise their landing plans, so he opted not to distract the captain with the unsettling discovery.

Forty feet above the ground—mere seconds before contact—Captain Pearson managed to wrestle Flight 143 back to a straight and level approach. At 8:38 P.M. central time, the rear landing gears grabbed the tarmac at Gimli airport. Bob Pearson stood on the brake pedals as the airplane skidded toward the scattering bystanders. The tires loudly protested the ill treatment, a few of them bursting with adequate force to shimmy the fuselage. As inertia shifted the aircraft's weight forward, the unsecured front landing gear buckled. The nose section struck the pavement, spraying a 300-foot shower of sparks.

After sledding across the asphalt for 2,900 feet, Air Canada Flight 143 ground to a halt just a few hundred yards from the shocked onlookers. There was a moment of stupefied contemplation within the passenger cabin, followed by an eruption of cheering and applause. Meanwhile a handful of racetrack workers dashed to the front of Flight 143 and used handheld extinguishers to douse the smoldering nosecone. Within a few minutes, the inflatable rubber escape chutes plopped from the sides of the plane, and the 69 frazzled occupants disembarked.

Out at Winnipeg airport, a crew of engineers clambered into a van and headed for Gimli to

assess the damage. During transit, however, their vehicle unexpectedly ran out of fuel, nearly ripping a hole in the delicate space-irony continuum. When airline mechanics finally arrived at the landing site, they found all three of the 767's fuel tanks completely dry, with no evidence of a fuel leak. A review of the day's events traced the problem back to the manual dipstick checks in Montreal and Ottawa. In order to maintain awareness of the overall weight of the aircraft, flight crews kept track of fuel quantity based on kilograms rather than the fuel company's liter-based measurements. Pearson and Quintal had determined the fuel weight by multiplying the number of dipsticked liters by 1.77, as instructed by the documentation. However, unbeknownst to the pilots and fuel crew, this multiplier provided the weight in imperial pounds; the new, all-metric 767 was based on kilograms, and required a multiplier of 0.8. As a consequence of this disconnect, Flight 143 had left Montreal with roughly half the necessary fuel.

Because the rear escape slides were quite steep due to the buckled front gear, a few bumps and bruises were sustained on egress, but no one was seriously injured in the Gimli incident. Had it not been for Pearson's capable captaining and glider experience as well as Quintal's cucumber-cool support, the outcome of the metric mix-up might have been considerably less pleasant. In addition, had it not been for the drag created by the collapsed front gear, the powerless plane would have plunged into the crowd of spectators, sowing destruction and death in its wake. All told, the soon-to-be-dubbed "Gimli Glider" was a nearly perfect demonstration of dead-stick flying, accompanied by an extra-large portion of good fortune.



■ *The "glider" came to a stop just a few hundred yards from the racetrack.*

After just two days of mechanical jiggering, Captain Pearson's wounded 767 was patched up sufficiently to fly it out for repairs elsewhere. The Gimli Glider officially rejoined the Air Canada fleet after a bit of bodywork, a new front gear, a repaired Fuel Quantity Indicator System, and a full load of jet fuel. The internal investigation into the incident laid the blame partially upon Captain Pearson and First Officer Quintal, because they failed to ground the aircraft once they discovered the fuel gauges were nonfunctional. Some of the responsibility was also assigned to the maintenance workers and to "corporate deficiencies." As a consequence, Pearson was briefly demoted and Quintal was suspended for two weeks. Nonetheless, both pilots continued to work for Air Canada, and in 1985 they received the well-deserved Fédération Aéronautique Internationale Diploma for Outstanding Airmanship for their handling of the unusual landing.

As for the Gimli Glider herself, the 24-year-old 767 remains an active part of the Air Canada fleet to this very day. Some grizzled old pilots swear that when the wind is just right on a quiet night, you can just about make out the double-engine-failure *BONG!* as the old girl is flying by; and if you're very lucky, you might catch the faint odor of damp pilots in the air.

GUPPY LOVE

Psychological insights from an unlikely source: fish

It has long been observed—though not scientifically—that women seem to show a vague preference for men who are already spoken for. This observation is known as “the wedding ring effect,” and there are numerous competing theories as to why it may be. Some suggest that the wedding ring is a cue that a man is “safe,” a passing opportunity for empty flirting; others theorize that the female psyche sees the ring as an indication that another woman has deemed him worthy and that stamp of approval makes him more desirable.

There is also the possibility that the increase in feminine attention is purely imagined, a way for a married man to reassure himself that he’s still got “it” (or, for that matter, that he ever had “it” in the first place).

Their findings suggested that heterosexual human males pay little attention to jewelry—whether or not she brandished a wedding band made scant difference in terms of philandering frequency.

It is weighty philosophical matters like these that have plagued civilization since its inception, but like so many of the great riddles, the answer may be found in a fish.



The animal kingdom analog of the wedding ring effect is called the “Guppy Syndrome,” so named because it was first documented in the guppy. It is often, and perhaps more properly, called “mate-choice copying.” To observe the effect, one takes a large tank filled with female guppies and adds about the same number of relatively indistinguishable male guppies. It doesn’t take too long for the guppies to get adjusted to the new environment, and they soon begin mating. As is true with most species, it is the females who determine who gets to score, and an odd thing occurs: Despite the fact that the males are all pretty much alike, some guys get all the luck and others are spurned.

Why are the females all lining up to mate with a small, privileged group of males? Is there a subtle physical difference that the females are basing their choices upon? Is there something in their social countenance?

In 1996, when this effect was first formally identified, a myriad of cruel scenarios were introduced to discover what was happening—for some reason,

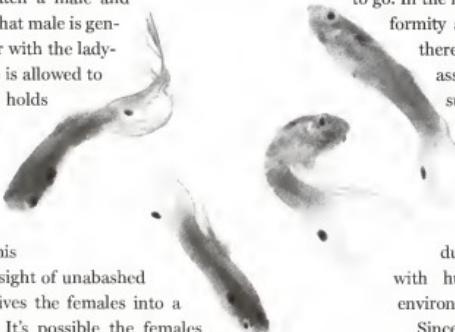
LOOK INTO MY EYES

In 1992, American psychologist Arthur Arun ran an offbeat but astonishingly powerful study on the origins of romantic attraction. After arbitrarily pairing off heterosexual strangers of opposite genders, Arun instructed the subjects that they were to spend 30 minutes speaking openly and extensively to their assigned partners about their own lives, and then simply look into each other's eyes silently for an uninterrupted period of four minutes. The results of this experiment were striking; many of the random pairs described being strongly attracted to one another, much more frequently than chance dictated. The effect was so profound that one of the study's randomly assigned couples even ended up getting married. However, for some reason no one bothered to record who could go the longest without blinking.

many scientists have a keen interest in finding out what makes individuals more attractive to the opposite sex. Generally a female guppy is attracted to a male with more color, but they found if a female is given the choice between a lonely but very colorful male and a lesser-colored but actively mating male, she'll go against norms and choose the male with less color. When a group of females are separated and allowed to watch a male and female going at it, that male is generally quite popular with the lady-fish when everyone is allowed to mingle again; this holds true even after more males are introduced.

There are a number of theories as to why this occurs. Maybe the sight of unabashed sexual congress drives the females into a frenzy of passion. It's possible the females assume that the male's previous partner had discovered some inconspicuous yet crucial quality that made him a superior mate. Or perhaps practice is the key to being a good mate, and females will always pick the male with more experience.

Mate-choice copying can be observed in several



species of fish and birds, but the real question is: Can we extrapolate this behavior to humans? Fish aren't known for their intelligence, rationale, or discrimination, so there are plenty of people who say that the behavior should be evident in humans as well. In a singles' bar one might observe that there is a group of men who receive the lion's share of courting, but that's as far as the analogy dares to go. In the night club there is no uniformity among the men, nor are there any controls over the assertiveness of potential suitors. Also, there is rarely copulation in full view of all the attendees. Those pesky "scientific ethics" hinder any effort to reproduce the Guppy Syndrome with humans in a controlled environment.

Since no one is willing to replicate the circumstances of the Guppy Syndrome for people, one can only speculate about the mental gymnastics a human mind makes in mate-choice copying. The wedding ring effect is one such con-

■ Some guppies get lucky, others are spurned.



■ *In an experiment on physical attraction in humans, the majority of female subjects preferred the men who were already receiving a woman's attention.*

tortion, but once again those pesky ethics bar science from any enlightening experimentation. In one attempt to study humans' tendency to seek more experienced mates, a woman was sent to sit in a bar for a long time. Sometimes she wore a wedding ring, and others not. A crew of hidden observers tracked how often she was approached. Their findings suggested that heterosexual human males pay little attention to jewelry—whether or not she brandished a wedding band made scant difference in terms of philandering frequency. And of course it revealed nothing at all about women's purported preference for married men.

In another, better-devised experiment, women were shown a series of photographs and asked to indicate which man they preferred. The photo cards depicted similar men's faces on the left and right sides, and a woman's face in the center; in each set

the female face was looking at one of the men, and wearing either a smile or a neutral expression. After perusing the array, the majority of the female subjects indicated that the men receiving the positive feminine attention were "more desirable."

Although there is not yet enough information to draw final conclusions, this groundbreaking research certainly supports the idea that human females—like their fish and bird counterparts—seem to much prefer men who are already fortunate enough to have female attention. Therefore it follows that the oft-described wedding ring effect may indeed be a real phenomenon, and not merely a product of married mens' imaginations. So far no practical applications of this psychological data have arisen, but even now scientists are selflessly laboring to find some way—any way—to redirect female attention to more deserving men.

THE HAIL FROM HELL THEORY

Freakishly large chunks of ice plummet randomly from the sky

Hail, in and of itself, is not an unusual weather phenomenon. The frozen precipitation occurs inside storm clouds when droplets of water are cooled below the freezing point yet remain in a liquid state. When the supercooled water encounters something substantial such as a speck of dust or an ice crystal, it clings to the particle and freezes solid. Updrafts in the storm keep the hailstone aloft as it aggregates ice, growing until its weight is too heavy for the updraft, at which time it plunges to the earth.

But some scientists believe there is a larger, more sinister type of ice-chunk precipitation that can form outside of storms, making even the largest hailstones look puny in comparison. There is a great deal of disagreement in the scientific community regarding the origin of these falling slabs of ice, but it is certain that something is causing massive frozen chunks to occasionally drop from seemingly empty skies. The objects are called megacryometeors.

The term was coined by researcher Jesús Martínez-Frias, a planetary geologist from Madrid, Spain. In 2000, he investigated a series of such mystery ice meteors. It all began with a four-and-a-half-pound object that smashed through the windshield of a parked car in the city of Tocina. It fell out of a clear, sunny sky in January. Soon there were reports of similar preposterous precipitation in the surrounding area, with some ice chunks as small as an apple and others as large as a cantaloupe. These inexplicable objects fell from the sky at irregular intervals for about a week before they stopped as mysteriously as they had started.



■ Here—catch this ice-chunk.

Martínez-Frias led the research on the objects in Spain, examining the ice and impact sites from multiple megacryometeors. The ice was found to be free of urine, feces, and disinfecting solutions, proving it was determined that its source was not an airplane's frozen wastewater. In fact, at the times of several of the events, the official records of air traffic control showed no airplanes in the skies over the areas in question. The makeup of the ice was vastly different from that of comets, so an extraterrestrial original was ruled out. But the composition of the frozen water did bear a very striking resem-

blance to that of a well-known weather phenomenon: hail.

Like hail, the mysterious ice blobs have been found to contain air bubbles, onionlike layering, and traces of ammonia and silica. The icy objects also have isotopic distributions of oxygen-18 and deuterium similar to those found in hailstones. Aside from their surprising mass and their tendency to plunge one at a time from clear skies, the ice balls are almost identical to hail. Adding further intrigue to the investigation, it was discovered that there were several peculiar conditions in the high atmosphere over Spain at the time: Ozone levels were lower than normal, causing the troposphere to be particularly warm and the stratosphere particularly cold. Additionally, the lower stratosphere was more humid than usual, and there was strong wind shear in the upper atmosphere.

Martinez-Frias and his team speculated that these meteorological ingredients may have worked

together to create a situation where ice balls formed high in the atmosphere. As they descended, they "snowballed," accruing additional ice until they reached enormous sizes. The scientists also theorized that the recent increase in the frequency of these megacryometeors worldwide may be due to the effects of global climate change.

Since 1996, more than 50 such objects have been recorded worldwide. One made headlines in Oakland, California, weighing over 200 pounds and creating a dent in the earth three feet deep. A similar event occurred in Chicago, when one crashed through the roof of a house. The most monstrous megacryometeor recorded so far was a mass of ice weighing almost a quarter of a ton, which crashed through the roof of a Mercedes-Benz factory in Brazil.

Many scientists are skeptical of the notion that these ice chunks are atmospheric conglomerations. Their most likely source, according to some, is pass-



Plummeting ice balls can do serious damage, including smashing this car widow in Munich.

RECIPES FOR RAIN

Serious attempts at directly modifying the weather have been recorded for more than a century. In one notoriously successful example, Charles Hatfield, a man known as the Rainmaker, was contracted by the San Diego city council in 1916 to fill the near-empty Morena Dam reservoir. Hatfield and his brother constructed a 28-foot tower, and just after the new year, they filled its evaporating tanks with a noxious chemical brew of Charles's design. Smoke and fumes wafted skyward. Within a few short days, the rains poured . . . and poured. Throughout January, the sky gushed water almost daily. Rivers flooded, bridges washed away, and dams burst. An estimated 20 people were killed. The city council refused to pay the \$10,000 contract, asserting that if were they to pay Hatfield, he would become legally liable for the damage. Despite his best efforts, he never squeezed a single dime out of the city council. His rainmaking recipe, whether it really worked or not, went with him to his grave.

It's certainly not beyond the realm of possibility that Hatfield's rain juice was the catalyst for the San Diego downpour. Modern meteorological meddlers occasionally use silver iodide or dry ice to coax clouds to dump their wet bounty, with wildly varying degrees of success. There is also evidence that humans' day-to-day activities can have a profound effect on the weather. Cynical observers have long grumped that the best weather seems to occur during the workweek, while the weekends tend to be more rainy and gray. Indeed, research in 1998 confirmed the pessimists' observations, revealing that the eastern seaboard of the U.S. receives 22 percent more rain on the weekends than on Mondays. The probable culprit: our internal combustion engines. Along with greenhouse gases and other pollutants, our tailpipes spew tiny particles called aerosols that provide a place for moisture to condense in the air. All week long commuters saturate the air with aerosols, inadvertently creating a cloudier Saturday.



ing aircraft. It may be that rainwater collects on the fuselage of aircraft, freezes during flight, and then becomes dislodged and falls to earth. Although Martínez-Friás was unable to find evidence of passing aircraft during the times of several events, it is possible that the flight-control records did not include all military and private aircraft.

Another possible explanation is that Martínez-Friás and his meteorological colleagues have been duped by an elaborate hoax, but that seems unlikely given the numerous megacryometeor events that have occurred worldwide over a span of many

years. Another factor ruling out a hoax is that there were recorded ice-meteor events (though they occurred with less frequency) before aircraft were even invented.

Whether or not one subscribes to the idea that humankind can have such a serious impact on our planet's weather systems, the hail-from-hell theory is certainly worth investigating. Regardless of the cause, it is alarming to consider that on occasion, very large chunks of ice can fall out of a clear blue sky without explanation. Even more troubling: It seems to be happening more and more.

WHEN METEORS ATTACK

No human has ever been directly hit by a megacryometeor, however on one occasion an old-fashioned rock-and-metal meteor struck a citizen of Sylacauga, Alabama. On November 30, 1954, a supersonic fireball smeared the sky over the southeastern United States. The trail of flame was visible from three states, and it shook the sky with a mighty boom. Moments later, Ann Elizabeth Hodges became the first and only person in recorded history to be struck by a meteorite.

The cantaloupe-sized space rock crashed through the ceiling of Hodges' rented home, collided with her console radio, and ricocheted toward the sofa where she was napping. After striking the surprised woman on her hand and hip, it ended its cosmic voyage on her living room floor. Hodges was bruised badly by the bizarre misadventure, but otherwise intact. News of the incident spread quickly, and the Air Force sent a helicopter crew to the Hodges' home to examine and confiscate the meteorite. Reporters and rubbernecks jammed the surrounding streets for days, eager to record the unprecedented event.

With the help of lawyers, the nugget of historic space debris was juggled between the Air Force, Hodges, and Hodges' landlady. By the time Hodges secured the legal ownership of her extraterrestrial souvenir, however, all potential buyers had lost interest. Hodges eventually donated the historic meteorite to the Alabama Museum of Natural History, where it remains on display to this day.



■ Ann Elizabeth Hodges shows off her meteor-sized bruise.



THE HALIFAX DISASTER

A clash of seafaring egos leads to catastrophic results

In 1917, two passenger trains bound for the port city of Halifax, Nova Scotia, were forced to make unscheduled stops. A station outside of Halifax had received a short, alarming telegraph indicating that a munitions ship was on fire in Halifax harbor. No word had been received since. The ship in question was the French ship *Mont-Blanc*, a French cargo freighter loaded with 2,700 metric tons of high explosives intended for the war effort in Europe. In Halifax, hundreds of onlookers were gathered on the harbor shores to watch the spectacular fire, unaware of the vessel's unstable contents.

About 20 minutes earlier, the not-yet-burning *Mont-Blanc* had been among the other ships shuffling into Halifax harbor through "The Narrows" after the wire-mesh antisubmarine nets were lifted for the day. The city lay alongside one of the world's largest natural harbors, and railroads connected the port with many other North American cities. The combination established Halifax as a major international port for supplies, troopships, and hospital ships destined for the Great War that was underway in Europe.

The *Mont-Blanc* had been meandering through the narrows at a leisurely four knots when the crew spotted the Norwegian relief ship *Imo* headed straight for them from the opposite direction. The Norwegians were traveling on the wrong side of the channel and moving at almost seven knots, exceeding the speed limit of the harbor. The aptly named Narrows left little room for maneuvering.

Mont-Blanc blew its whistle once—the standard signal to assert right of way—to direct the *Imo* to move into the proper channel. The *Imo*'s whistle

sang out twice in response, signaling that its captain had no intention of altering his course. The nautical dialog of whistles continued as both captains refused to yield, the signals growing more frantic as the distance closed. There were reasons for the *Imo*'s insistence on staying its course, but at the last moment, when a collision was imminent, both captains ordered evasive maneuvers. The *Mont-Blanc* turned hard to the left, and the *Imo* put all her engines in full reverse. The *Imo* drifted into the center as she decelerated, putting her once again into the path of the *Mont-Blanc*. The two hulls came into contact with the tremendous screech of steel upon steel, spraying sparks as *Imo*'s prow scraped along the starboard side of the freighter. Hot steel particles showered the *Mont-Blanc*, falling onto the barrels of benzol fuel stored on her deck. The volatile fuel vapors ignited, and the crew of the French munitions ship wasted no time in disembarking.

The abandoned vessel drifted slowly into the harbor swamped in benzol-fed flames. Bystanders gathered on the piers and beaches to watch the brilliant



■ Searchers look for bodies amid the wreckage near the harbor.

flames, oily black smoke, and lifeboats full of shouting, wildly gesticulating Frenchmen rowing toward the shore. Unfortunately none of the Halifaxan bystanders understood French, so they weren't able to grasp the severity of the danger. Ordinarily a ship with such hazardous freight would be marked with warning flags, however the *Mont-Blanc* was unmarked to prevent its precious munitions cargo from being targeted by the U-boats of the German Imperial Navy. Upon reaching the shore, the Frenchmen clambered from their lifeboats and ran inland as fast as their legs could carry them.

The burning ship crossed the harbor lazily and crashed into a pier on the west side, setting the wooden pilings ablaze as hundreds looked on. A nearby tugboat trained its fire hose on the *Mont-Blanc* and attempted, without success, to tow the ship away from the pier. The land-based fire department also arrived in its fancy new motorized fire engine and rolled out the hoses in an attempt to douse the flames.

The harbor staff, quite familiar with the ship's explosive cargo, was already organizing an evacu-

ation. Employees of the waterfront businesses were ordered to depart, and the workers for the Intercolonial Railway of Canada were warned to leave the area. As the evacuation ensued, a train dispatcher named Vincent Coleman realized that two passenger trains were still inbound from Bedford. He turned back and headed to the telegraph office, where he hastily tapped out a message to Rockingham Station: "Munition ships on fire. Making for Pier 6. Good-bye." His quick thinking probably saved the lives of the passengers on the incoming trains, but it was the last thing he ever did.

At 9:04 A.M., after weathering the inferno for 20 minutes, *Mont-Blanc*'s massive cargo of TNT, picric acid, and benzol ignited. In an instant, a cubic mile of air was consumed by an explosion as powerful as a three-kiloton atomic bomb. The *Mont-Blanc* was completely annihilated, and its red-hot remains were projected in every direction with terrific speed. The blast pushed upon the sea with such force that the floor of the harbor was exposed. A pressure wave flattened 300 acres of Halifax's buildings and burst every window within 50 miles. Doors were blasted

open and wood stoves were tipped over, sparking numerous fires throughout the area. About a thousand people were killed instantly, and thousands more suffered gruesome injuries from the missiles of shattered glass and splintered wood that peppered the city.

The sea, displaced by the force of the blast, rushed over the land as an unnatural tsunami. It reached 60 feet above the high-water mark, toppling smokestacks and wrenching buildings from their foundations. Ships were tossed ashore by the massive wave, including the troublemaking *Imo*. The rush of superheated air caused cyclones around the harbor, while the twisted, red-hot remains of the *Mont-Blanc* began to rain upon Halifax and the city of Dartmouth across the harbor.

Where pier six had once been, a black mushroom cloud began to rise into the sky. Meanwhile the displaced water drained back into the harbor, dragging wreckage and residents into the sea. Many survivors of the initial blast were convinced that the Allied port had been bombed by Germany, but there was little time to consider the cause of the catastrophe. Entire city blocks were afire, and countless Halifaxians were injured or trapped in the rubble.

The area of Halifax along the shoreline—what had been known as Richmond—made up the majority of what would soon come to be known as the “Devastated Area.” The streets of the city were a grim scene, littered with severed arms, legs, heads, and mutilated torsos. A substantial portion of the population had received injuries, particularly to

the face and eyes, since so many people had been watching the fire through their windows. Hospitals were rapidly filled beyond capacity. Victims whose lives were not in immediate peril were directed away from the hospitals to aid stations. In the pandemonium of triage, some battered survivors awoke in the backrooms of medical facilities, left for dead. Local doctors also offered their homes as emergency treatment centers, performing surgeries on their own kitchen tables and using torn-up shirts for bandaging.

Two American ships that had left Halifax only a few hours earlier turned back after witnessing

the massive explosion, offering the assistance of their medical nurses and orderlies. Firefighters from neighboring cities arrived to help extinguish the city, but many of their fire hoses were of different sizes and unable to connect to the Halifax taps and hydrants.

About an hour after the first blast, rumors of another impending explosion spread when a column of smoke was



■ A Halifax church sustained heavy damage from the explosion.

seen rising from the naval ammunitions magazine at Wellington Barracks. Survivors fled to higher ground, suspending rescue efforts for almost two hours until the situation was cleared. The second explosion never came, but the distraction was a significant setback.

Many Halifaxians were left homeless by the disaster, spending the cold winter night in whatever shelter they could scavenge. Those whose homes still stood were left without windows. In the morning, snow began to fall, developing into a legitimate blizzard as the day progressed. Sixteen inches of snow

hampered efforts to dig out survivors and collect the dead, but helped to smother the few remaining fires.

Makeshift mortuaries were left with the grim duty of processing bodies, which arrived by the dozens. Trains left the city filled with the dead, injured, and homeless and returned with cars full of able bodies to lend assistance. American medical teams began arriving 48 hours after the explosion, offering relief for exhausted doctors, nurses, and rescue workers. On the far side of the harbor, Dartmouth was less hard-hit, but far from spared. Approximately 100 people died there, and many of its buildings were

damaged by the blast. All told, about 2,000 men, women, and children were killed that day in Halifax and Dartmouth, and some 9,000 injured.

At the time, the Halifax explosion was the most powerful explosion that had ever been created by man. One of the *Mont-Blanc*'s mighty cannon barrels was later found three and a half miles from the blast site, and a half-ton fragment of her anchor was discovered two miles in the opposite direction. The event would hold the record as the most powerful man-made explosion for the next 28 years, when it was bested by the first atomic bomb test.

THE RAZZLE-DAZZLE CAMO OF WORLD WAR I

An ocean away from Halifax, the naval front of World War I was undergoing a curious transformation. German U-boats were sinking the Allies' vessels at an alarming rate. All attempts to camouflage their vulnerable ships had proven unsuccessful until 1917 when artist and British naval lieutenant Norman Wilkinson came up with a radical new approach. Rather than trying to hide ships beneath drab blues and grays, Wilkinson suggested blazoning them with brilliantly colored stripes and geometric shapes. The new camouflage would come to be known as "dazzle painting," or "razzle dazzle."

The secret to razzle dazzle was that it wasn't really camouflage. In the days before radar and sonar were perfected, naval artillery had to be manually targeted by an operator looking through a range finder. This was a tricky process, as the operator couldn't simply point at a target and shoot; he had to factor in the distance, speed, and direction of a ship. Drawing on cubist art, dazzle paint covered ships in spectacular patterns that broke up the lines of a craft and made it difficult for the enemy to make these vital estimates. Contrasting curves, stripes, and zigzags hid the major features of a ship and created the illusion of multiple bows and bow waves. Enemy crews didn't know if the target was coming or going.

The widespread adoption of razzle dazzle that followed made for a highly unique period in naval history: one that had the world's top militaries employing teams of abstract artists to design camouflage and turned naval harbors and convoys into marvelous cornucopias of color. It was to be short-lived, however. By midway into World War II, superior range-finding technologies had made dazzle camo obsolete. Navy brass, who had never been entirely comfortable with the undignified look dazzle gave to their boats, soon had their fleets repainted in somber gray. The striking patterns of razzle dazzle were relegated back to the world of art from whence they came.



HIGH-RISE SYNDROME

How cats can fall hundreds of feet and survive

As most people know, a falling cat will almost always land on its feet. It is a nifty knack they have evolved over eons of climbing trees to capture prey, evade predators, and otherwise look down on the world from a high bough. Although the cat's claws are shaped in an arc that is better suited to climbing than for use as weapons, they are still the tools of agile and capable hunters.

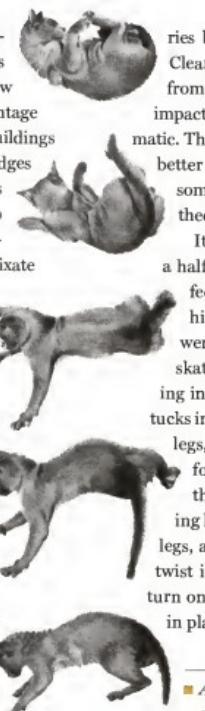
Among the feline's numerous predatory gifts is the capacity to fixate on his prey—a skill useful when chasing a shrew through the grass, but a serious disadvantage in the urban world. People living in tall buildings often allow their cats to sit on window ledges and fire escapes, unaware that the traits that allow cats to leap from bough to bough aren't nearly as effective in a concrete jungle. Cats have been known to fixate on some perceived prey outside, spring after it, and fall from hundreds of feet up, an occurrence frequent enough that urban veterinarians have coined a term for it: High-Rise Syndrome.

Astonishingly, when given prompt medical attention, cats that sustain a fall from between 2 and 32 stories have an amazing 90 percent survival rate. In fact, cats falling from lower floors have been found to suffer greater injury than those falling from higher floors.

According to data from veterinarians in New York, cats are most likely to survive if they fall from a height of six stories, with heights over seven sto-

ries being only slightly more dangerous. Clearly, if a person were to take a spill from six stories up, the 40-mile-per-hour impact with the earth would be rather traumatic. The reasons why our feline masters can better deal with such punishment are still somewhat nebulous, but the reigning theory is threefold.

It takes a normal cat about a two and a half feet of free fall to orient himself to feet-down. It wasn't until the advent of high-speed cameras that the acrobatics were fully understood: Much like an ice skater controls her rate of spin by pulling in or extending her arms, the cat first tucks in his front legs and splayts out his rear legs, allowing him to quickly situate his forequarters with the feet down. He then reverses the procedure, extending his front legs and tucking in the rear legs, allowing the hindquarters to rapidly twist into position while the forequarters turn only slightly. Rear legs reextend when in place, and he's fully deployed.



■ A cat demonstrates the proper way to survive a fall from six stories.

This position is ready for landing, but it also lends the cat a higher aerodynamic drag—much like the flying squirrel. The ability to increase drag slows a cat's average terminal velocity from a person's 130 mph to a much more manageable 60 mph.

The fact that cats can twist so quickly to attain feet-down contributes to survivability of High-Rise Syndrome, but it's not the end of the story. In order to perform the righting maneuver, many muscles have to fire fast and in sequence, and the immediate aftermath of a quick muscle pull is tension; tension is anathema to surviving an impact. Releasing the tension is why six to seven stories seems to be the prime falling altitude: It gives the cat time to unwind after the hard twist and relax into the free fall for a moment before landing.

The record belongs to a feline named Voodoo, who survived a fall of 36 stories—though there are rumors of a cat who survived a fall from the 64th

floor of a New York high-rise. The ASPCA notes on its website that sometimes the owners of pets that fall from heights immediately write them off as dead and don't bother to go and seek out their lost critters. How rotten would it be to survive a catastrophic vertical trip only to be left abandoned in the world below without access to the food bowl?

Therein lies a quandary: There is a distinct possibility that the data pertaining to High-Rise Syndrome is skewed. High-Rise Syndrome

was added to the lexicon by veterinarians, implying that they gathered the data from animals brought to them for care. But if poor Fluffy ends up a pancake, few cat owners would bother taking him to the vet. Still, even if the survival rate isn't quite as high as the anecdotal numbers suggest, it is nonetheless amazing that a significant number of the cats leaping from the upper floors of high-rise buildings live to nap another day.

SPEAKING OF LANDING . . .



There is truth in the folk wisdom that toast will almost always land buttered-side-down when dropped. The reason for this disagreeable behavior is simple Newtonian physics. Toast is typically oriented in a butter-side-up position in the predropped stage, and at a height of approximately four feet. Once the toast's center of gravity goes over the edge of the surface it is sitting upon, it descends to the floor with a predictable tumbling pattern. Unless it strikes an

object during descent, thereby imparting an irregular tumbling pattern, the buttery bread has only enough distance to tumble halfway around before arriving at the floor. Consequently the sticky side is frequently floor-ward.

To remedy this, one can transport one's toast in a butter-down configuration or alter the toast-toting height to be something less than two feet from the floor or greater than ten feet.

INTERSTELLAR EAVESDROPPING

Hello? Is there anybody out there?

Owing to radio's aptitude in transporting information, our planet is peppered endlessly by man-made low-frequency radiation. Cell phone conversations, computer data, text messages, radar echoes, sitcoms, and morning DJ chatter are all electromagnetically belched in every direction at the speed of light—including into outer space.

Purveyors of science fiction are fond of exploring the ramifications of this radio leakage, suggesting that someday, after a little electromagnetic eavesdropping from afar, an advanced alien race might materialize to befriend, enslave, or destroy humanity. Indeed, if there happen to be any radio-savvy civilizations within 114 light-years of Earth—an area that encompasses roughly 15,000 stars—humanity's earliest meaningful transmissions will have already reached them.



■ Statistically speaking, it is almost certain that there are other intelligent civilizations in the Milky Way.

Similar speculation appears in science nonfiction, such as the Search for Extra-Terrestrial Intelligence (SETI) project, which strains its giant radio ears for extraterrestrial signals. The wisdom of probability suggests that the universe ought to be teeming with technology-toting aliens; but aside from a couple of interesting but inconclusive detections, no discernibly intelligent patterns have ever been observed by Earth's space-listening instruments. One could surmise that the conspicuous silence is "evidence of absence," but such a conclusion might be a bit premature.

Outer space, as it was aptly put by the late Douglas Adams, is "vastly, hugely, mind-bogglingly big." Astronomy's most up-to-date observations and calculations number the stars in the visible universe at somewhere around 70 sextillion (7×10^{22}), an incomprehensible value that is seldom welcome in polite company. This figure is so formidable that any attempt to scale it for human consumption results in such impotent analogies as "ten times as many stars as grains of sand on all the world's beaches and deserts," or "ten trillion stars for every man, woman, and child on Earth."

At least 200 billion of these stars reside within our own 13-billion-year-old galaxy, along with

THE DRAKE EQUATION

$$N = R^* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

The Drake Equation arrives at an estimate by multiplying all of the following values together.

Use decimals for the percentage-based answers (50% = 0.5).

- Average number of stars formed in the galaxy annually
(about six, according to NASA)
- Percentage of stars that have one or more planets
(at least 10 percent, probably more)
- Average number of planets per solar system where basic life could potentially appear (unknown, but our own solar system suggests 1-2)
- Percentage of life-compatible planets where life eventually does appear
- Percentage of planets where *intelligent* life evolves
- Percentage of civilizations that eventually send signals into space (TV, radio, etc.)
- Average number of years that an advanced civilization will send such signals
- = **Probable communicating civilizations in our galaxy**

For an interactive version of the Drake Equation, go to <http://astro.nomical.info/drake>.

millions or billions of planets and moons. Considering the abundance of potential habitats and the amount of time our galaxy has been around, it seems inconceivable that our unremarkable planet is the only one that has produced intelligent, signal-radiating life. Even if a solar system's odds of developing intelligent life is only one-in-a-billion, that means that the Milky Way should be home to 200 or so past or present civilizations, in addition to some 70 billion among the other galaxies.

The Drake Equation illustrates that our own humble galaxy is almost certainly home to at least one other advanced civilization at present.

In 1950, famed physicist Enrico Fermi was one of the first to popularize the discrepancy between probable and observable life in the universe. While lunching with colleagues and discussing the notion

of interstellar neighbors, Fermi summed up the question by wondering aloud, "Where is everybody?" Thereafter the inconsistency was known as the Fermi Paradox. The paradox is a product of science's Mediocrity Principle, the observation that Earth seems to be an ordinary planet orbiting an ordinary star within an ordinary galaxy. It follows, therefore, that Earth-like planets are probably somewhat common.

In 1961, ten distinguished scientists and engineers met in West Virginia to form the Order of the Dolphin, an organization committed to filling this astronomical hole in human knowledge. They pondered the possibility of employing massive radio telescopes to scan the sky for stray extraterrestrial signals, a concept that eventually evolved into SETI. During these early discussions, astronomer Dr. Frank Drake first described a formula to estimate the number of technologically advanced civilizations within the galaxy at a given time. To this day the Drake Equation remains as a framework for extraterrestrial speculation. There is much fist-shaking and spittle-making debate regarding most correct inputs, but as we have



■ Dr. Frank Drake with his famous equation.

gradually increased our knowledge of the universe in the intervening decades, our guesses for these values have become far more educated.

Even when using NASA's somewhat conservative inputs, the Drake Equation illustrates that our own humble galaxy is almost certainly home to at least one other advanced civilization at present, along with the lingering physical and electromagnetic remains of many others. Drake's original estimates in 1961 indicated ten or so communicating planets in our galaxy. With information gathered over the years, he revised his inputs in 2004, leading to a prediction of about 10,000 signal-sending civilizations. Massive radio telescopes have scoured the sky for such alien signals, including efforts by the Big Ear Observatory in Ohio; the Very Large Array (VLA) in New Mexico; and the famous Arecibo Observatory in Puerto Rico, the largest single-aperture telescope ever constructed. In 47 years of signal-seeking, SETI twice detected signals of possibly intelligent origins—the "Wow!" signal in 1977 (see the sidebar on the next page) and Radio Source SHGb02+14a in 2004. But both had plausible earthly explanations,

so science must assume for now that they were not of extraterrestrial origin. The failure to find any stray radio evidence is taken by some as an indication there may indeed be something special about our planet and its location in the cosmos.

The Rare Earth hypothesis is the antithesis to the Mediocrity Principle, suggesting that complex life requires an extremely uncommon combination of astrophysical and geological events and circumstances: a slightly tilted planet with just the right chemistry, a large moon, a suitably metallic sun, and an orbit at just the right distance. The hypothesis also advances the notion that there is a narrow galactic habitable zone where radiation levels are survivable, rogue meteors are few, and gravitational perturbations from neighboring stars are negligible. If all life relies upon such factors, then Rare Earth resolves the Fermi Paradox. The hypothesis carries the faint odor of anthropomorphic bias, however, since it assumes that all complex life must be very much like humans.

All these factors aside, there is one additional daunting obstacle that complicates any effort to

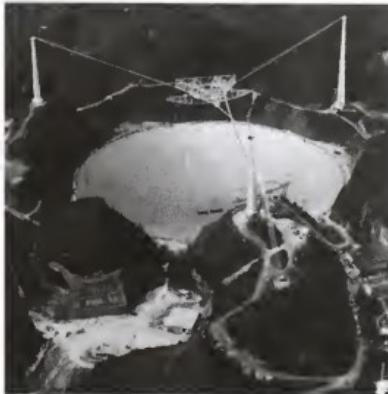
THE ONE AND ONLY "WOW!" SIGNAL

On August 15, 1977, a volunteer at the Big Ear radio in Ohio observatory spotted a strange reading in the log printouts. He circled the data and wrote "Wow!" in the margin. The radio telescope was observing space as part of the SETI program, and this was the most compelling signal the receiver had recorded in its 14 years of operation. It was powerful enough to push the Big Ear's monitoring device off the charts.

Amazed at the signal's intensity and what a narrow range of frequencies it appeared in, researchers did some analysis of the data. By all indications, this powerful, narrowband radio signal was from outside of our solar system. In many ways it resembled what one of Earth's powerful radar signals might look like if monitored from another planet.

Though no repeat signal was ever detected, "Wow!" remains the strongest and clearest signal ever received from an unknown source in space, as well as the most fascinating and unexplainable. The signal's discoverer, Jerry Ehman, doesn't care to speculate on its source. "Even if it were intelligent beings sending a signal," he said in an interview, "they'd do it far more than once. We should have seen it again when we looked for it fifty times."

Perhaps. But when humankind used the Arecibo radio telescope to send a message out into space in 1974, it was sent only once.



■ *The Arecibo observatory's 305-meter radio telescope is the largest single-aperture telescope ever constructed.*

tune in to intergalactic radio. Even if the universe is thick with signal-slinging civilizations, including some old enough that their indiscriminate electromagnetism has had sufficient time to reach Earth, not even the most massive and sensitive equipment of science is currently capable of plucking the signal from the static. When any nonfocused electromagnetic signal is generated—such as a television broadcast or cell phone conversation—the energy propagates as a spherical wave front at the speed of light. When a sphere is doubled in diameter, its surface area increases by a factor of four; but in a spherical wave, the "surface area" is the energy itself. This means the signal's energy is spread over four times more area at twice the distance, resulting in a 75 percent loss in intensity. To put it another way, in order for a broadcasting tower to double its effective range for a given receiver, it must quadruple its transmitting power.

To demonstrate the degrading effect of distance on an everyday omnidirectional signal, one might imagine a spacecraft equipped with an Arecibo-style radio receiver directed toward Earth. If this

hypothetical spacecraft were to set into space, its massive 305-meter-wide dish would lose its tenuous grip on AM radio before reaching Mars. Somewhere en route to Jupiter, the UHF television receivers would resolve nothing but static. Before passing Saturn, the last of the FM radio stations would fade away, leaving all of Earth's electromagnetic chatter behind well before leaving our own solar system. If a range-finding radar beam from Earth happened to intersect the ship's path, it would be observable from a much greater distance, though its short duration and smooth, Gaussian meaninglessness would make it an inconclusive detection—much like the Wow! signal and Radio Source SHGb02+14a. A highly focused beam such as that used to communicate with space probes would also remain detectable

for some distance beyond the edge of the solar system.

If hypothetically, A) a race of extra-intelligent extraterrestrials happened to reside in the nearby Alpha Centauri star system, B) they happened to broadcast a five-megawatt UHF television signal, and C) we were fortunate enough to be pointing the mighty Arecibo telescope directly toward the source when it arrived four years later, we would still be unable to enjoy the zany capers of the Alpha Centauri equivalent of *Mork & Mindy*. A dish with a diameter of 33,000 kilometers would be required to detect such a signal from this relatively proximate star. Even using Very Long Baseline Interferometry to link two Arecibo-style radio telescopes on opposite sides of the planet—thereby providing a virtual radio telescope the



The Very Large Array consists of 27 independent antennas that all work together as an enormous whole.

INSTANT TELESCOPE: JUST ADD LIQUID!

Sir Isaac Newton, the consummate polymath, described both the shape of a rotating liquid and invented the reflector telescope. Around 200 years later, in 1850, Italian astronomer Ernesto Capocci combined the two by rotating a dish of mercury. The theory is an elegant one: Mercury



is a silvery molten metal at room temperature, and a rotating liquid forms a paraboloid, the ideal shape for a telescope mirror. In practice, however, Capocci and his contemporaries found the mirrors too problematic, and the liquid metal telescope (LMT) was abandoned. In 1982, Ermanno Borra pointed out that technical improvements had finally made LMTs practical.

■ *Among Sir Isaac's many achievements was the invention of the reflector telescope in 1669.*

Most astronomers continued business as usual, casting, grinding, and polishing heavy mirrors of glass or aluminum. A bigger mirror means a deeper view—as long as the mirror is perfect. Hence progress in telescropy means shelling out big bucks. But Borra and Paul Hickson of the University of British Columbia broke the price-performance curve in 2000 with the Large Zenith Telescope (LZT), a reflector with a six-meter mirror of liquid metal. It cost a cool million—where an equivalent traditional scope would have cost \$100 million. It's so inexpensive they don't even have to share with anybody else. And it works so well, Hickson has set his sights on future 8-, 10-, even 12-meter LMTs.

The price tag has a catch: Current LMTs can only point straight up (the "Z" in LZT). This isn't as bad as it might sound; asteroids and space debris may wander by on their own, and if one peers through the telescope year-round, the tilt and rotation of the Earth parade a healthy swath of sky past one's view. However, the vertical view may not be a pain in the neck for much longer. Borra has developed a shiny silver colloid that can lay atop many fluids, and he plans to push the limits: By using liquids that are thicker than mercury, it may be possible to tilt the mirror up to 30 degrees. This silver lining allows LMTs to be used where mercury would freeze solid, making far-out plans possible: NASA is flirting with the idea of setting up a giant LMT in a shady lunar crater, giving us our best chance yet to find other pale blue dots like Earth.

size of the entire Earth—our antenna area would still be 20,244 kilometers too small.

By coupling the laws of probability with our best current observations, we can be reasonably confident that some fraction of the 70,000,000,000,000,000 star systems in the visible universe are home to radio-sending species. It may indeed be that our planet is subjected to an unending

spray of alien TV and radio signals, though they'd be attenuated beyond our best hardware's receiving extremes. Unless we dramatically improve our interstellar listening skills or some alien race makes a specific and vigorous attempt to send us a message, there is little chance that we earthlings will be trading messages with our astronomical neighbors anytime soon.

IRRATIONAL OPTIMISM

If you think you're well-adjusted, you're deluding yourself

Most people think of "the mentally disordered" as a delusional lot, holding bizarre and irrational ideas about themselves and the world around them. A mental disorder is supposed to be, after all, an impairment or distortion in thought or perception. For most of modern psychology's history, the experts have agreed that realistic perceptions are essential to good mental health. Recent research, however, has challenged this widely held, commonsense notion.

In 1988, psychologists Shelly Taylor and Jonathon Brown published an article making the somewhat disturbing claim that positive self-deception is a normal and beneficial part of most people's everyday outlook. They suggested that average people hold cognitive biases in three key areas: first, viewing themselves in unrealistically positive terms; second, believing they have more control over their environment than they actually do; and third, holding views about the future that are more positive than the evidence can justify. The typical person, it seems, depends on these happy delusions for the self-esteem needed to function through a normal day. Problems begin to arise when the fantasies start to unravel.

Consider eating disorders. It's generally been believed that an unrealistically negative body image is an important factor in the self-abuse that characterizes anorexia and bulimia. A 2006 study at the University of Maastricht in the Netherlands, however, came to a very different conclusion. In the study, groups of normal and eating-disordered women were asked to rate the attractiveness of their own bodies. They were then photographed from the neck down, and panels of volunteers were brought in to view the pho-



■ "So tell me, madam, how long have you been suffering these cheerful feelings?"

tos and rate the women's appearances objectively. The normal women, as it turned out, evaluated themselves much more positively than the panels did, while the self-ratings of the eating-disordered women were in close agreement with the objective ratings. The eating-disordered subjects, in other words, had a *more* realistic body image than the normal women.

Of course, none of this meant that the eating-disordered women didn't have delusions of their own. The weight of the subjects was a controlled variable, so it was not the basis of the volunteer panels' assessments—even though the women themselves may have rated themselves poorly because they felt "fat." The researchers speculated that the subjects' eating disorders may have grown out of the women's general dissatisfaction with the unchangeable parts of their body—for instance, their bone structure—which they transferred to something they could control: their weight. Thus, because they lacked the *healthy* delusion of viewing themselves as more attractive than they were in reality, the disordered women developed the *unhealthy* delusion of believing they were overweight.



■ Sometimes a depressed person has a more accurate perception of reality than an optimistic person.

Studies of clinical depression have yielded similar findings. This has led to the development of an intriguing, but still controversial, concept known

How does one reassure a depressed person that "everything is all right" when her life really *is* terrible?

as depressive realism. This theory posits that depressed individuals actually have more realistic perceptions of their own image, importance, and abilities than the average person. While it's still generally accepted that depressed people can be negatively biased in their interpretation of events

and information, depressive realism suggests that they are often merely responding rationally to realities that the "well-adjusted" person cheerfully denies.

Those with paranoid disorders can sometimes possess a certain unusual insight as well. It has often been asserted that within every delusional system there exists a core of truth—and in their pursuit of imagined conspiracies against them, these individuals often show an exceptionally keen eye for the real thing. People who interact with such paranooids may be taken aback as they find themselves accused of harboring some negative opinion of the person that, secretly, they actually do hold. Complicating the issue,

AUDITORY MISERY

Some people can't help but pick at a scab. Or probe a sore spot over and over. Or take a third look at that picture of an infected wound in a textbook. They just can't help themselves.

Scientists are chock-full of this same morbid curiosity. To such ends, Professor Trevor Cox of the University of Salford, U.K., has embarked upon a vital quest to determine the World's Most Unpleasant Sound. Thousands of participants worldwide visited his Internet site and rated each noisome noise according to how well it stimulated the negative reinforcement centers of their brains.

The hands-down winner is the sound of vomiting (simulated, mercifully). Rounding out the top ten list, in order, are: microphone feedback, many crying babies, braking trains, squeaking seesaws, bad violin playing, flatulence, one crying baby, soap-opera arguing, and humming electricity. Different folks react differently; the British despise vomiting more than North Americans, while the latter react more strongly to chalkboard scraping than the rest of the world. Women are more sensitive to most of the sounds than men, with one exception: crying babies.



of course, is the fact that if the supposed aversion didn't exist before, it likely does after the unpleasant encounter.

Naturally, these issues present some problems when it comes to treatment. How does one reassure a depressed person that "everything is all right" when her life really *is* terrible? How can an obsessive-compulsive patient be convinced to stop religiously washing his hands when the truth of what gets left behind after "normal" washing should be enough to make any sane person cringe? These problems put therapists in the curious position of teaching patients to develop irrational patterns of thinking—patterns that help them view the world as a rosier place than it really is. Counterintuitive as it sounds, it is justified, because what defines a mental disorder is not unreasonable or illogical thought but abnormal behavior that causes signifi-

cant distress and impairs one's ability to function in society. Successful treatment means restoring a person to a level of normal functioning and satisfaction, even if it means building cognitions that aren't precisely "rational" or "realistic."

It's a disconcerting concept. It's certainly easier to think of the mentally disordered as lunatics running about with bizarre, inexplicable beliefs than to imagine them living with a piece of reality that a "normal" person can't handle. The notion that most people routinely hide from the truth is not an appealing one, though it may help to explain the human tendency to ostracize the abnormal. Perhaps the reason we are so eager to reject any departure from this fiction we call "normality" is because we have grown dependent on our comfortable delusions; without them, there is nothing to insulate us from the harsh cold of reality.

THE KOLA SUPERDEEP BOREHOLE

The unexpected findings below the Earth's crust make this boring fascinating



In the early 1960s, a team of geologists in the Soviet Union were laying down plans to probe the depths of the Earth. Specifically, they were on a mission to be the first to penetrate the Earth's upper crust and sample the warm, mysterious area—known as the Mohorovičić discontinuity, or “Moho”—where the planet's crust and mantle intermingle. So deep is this area that the Russian scientists had to invent entirely new ways of drilling, and no one was certain what they would encounter along the way. The project was known as the Kola Superdeep Borehole.

The USSR's Interdepartmental Scientific Council for the Study of the Earth's Interior and Superdeep Drilling spent years preparing for the colossal mission. Project leaders began surveying possible drill sites in 1962, even as Russian rocket scientists were plotting to defeat the decadent capitalists in the space race. Indeed, the United States had embarked upon a similar superdeep drilling project in 1957, but that attempt to drill through the ocean floor had been canceled due to lack of funding. After searching and studying for three years, the Soviet scientists decided to drill on the Kola Peninsula in the northwest portion of the Soviet Union.

At the time, the state of the art in deep-drilling technology was a system that used a very long rotating shaft, adding extensions as the hole grew deeper. A special “drilling mud” was continuously pumped to the bottom of the hole to lubricate the drill bit and to carry the rock cuttings up to the surface. This method allowed the large, high-torque drilling engine on the surface to project its strength

down a narrow hole. But to reach the Soviets' goal of 15,000 meters, a preposterous number of extensions would be needed. It was also unlikely that the miles and miles of segmented shaft could withstand the extreme stress and heat. To have any hope of penetrating the crust of the Earth, Russian researchers needed to devise a new kind of drill.

“Every time we drill a hole we find the unexpected. That’s exciting, but disturbing.”

Their solution was to utilize a mighty engine on the surface to pump the drilling mud into the hole under extreme pressure, using this hydraulic force to spin the specially designed bit at the business end of the drill. They called their contraption the “Uralmash-4E.” Engineers erected a 200-foot-tall enclosure to house the massive experimental drill-

ing apparatus, and in 1970 the drill began its long, ponderous journey.

Fortunately the Soviets had the foresight to design their rig to provide core samples along the entire length of the drill shaft, furnishing surface-

the surface. This conclusion was based on decades of observations that indicated that seismic waves travel significantly faster below that depth. But rather than finding a "basement" of basalt, researchers encountered "metamorphic rock"—rock that has been transformed at the molecular level by the intense pressure and heat of the deep crust. Even more surprisingly, the nooks and crannies of this deep rock were filled with water. Because "free" water should be unable to trickle down to such depths, scientists believe that the water was formed by hydrogen and oxygen atoms squeezed out of the surrounding rocks by the incredible pressure. This spontaneously generated water was prevented from rising to the surface by the layer of impermeable rocks above it.

Another unexpected find was a menagerie of microscopic fossils as deep as 6.7 kilometers below the surface. Twenty-four distinct species of plankton microfossils were detected, and some were found to possess carbon and nitrogen coverings rather than the typical limestone or silica. These microscopic remains were remarkably intact despite the unforgiving environment. Large amounts of hydrogen were also found deep in the bowels of the Earth, causing the drilling mud to emerge from the hole "boiling" with the highly flammable gas.

On June 6, 1979, the Kola Superdeep Borehole broke the world depth record held by the Bertha Rogers hole in Oklahoma (9,583 meters). The Russian researchers were surprised at how quickly the temperatures rose as the main branch of the borehole—branch SG3—burrowed into the crust. To prevent the drill from exceeding its maximum heat tolerance, engineers began to refrigerate the drilling mud before pumping it down the hole. But as the drill approached 12 kilometers in depth, even the researchers' most creative efforts were no longer effective. At that depth researchers had estimated that they would encounter rocks at 100°C (212°F), but the actual temperature was about



■ Who would think that this building houses the world's deepest borehole?

dwellers with an intimate look at the composition of the earth's layered crust. These samples provided some unexpected insights into the planet's composition. As is often the case when humans venture into the unknown, a few scientific theories were left in tatters. One scientist was heard to comment, "Every time we drill a hole we find the unexpected. That's exciting, but disturbing."

Before the Soviet boring machine punched holes in geologists' theories, it was generally believed that the Earth's top layer of granite would give way to basalt around three to six kilometers below

180°C (356°F). If the temperatures continued to increase at the same rate, the drill would be chewing through rocks at 300°C (572°F) by the time it reached the target depth of 15,000 meters. Also contributing to the trouble was the fact that the heat and pressure caused the rocks to behave more like a plastic than a solid, and the rock surrounding the hole had a tendency to ooze inward whenever the drill bit was pulled out for replacement. Forward progress became impossible without some technological breakthroughs and major renovations

of the equipment on hand, neither of which was forthcoming. Drilling continued in the other, less deep branches, but branch SG3 had reached the practical limits of human engineering

In 1994, the Kola Superdeep Borehole project—one of the last remaining super-projects of the old Soviet Union—was finally halted. In its 24 years of

drilling, it had succeeded in penetrating seven miles (12,262 meters) into the earth, making it by far the deepest hole ever drilled by humankind. The last of the core samples plucked from the nine-inch-wide borehole was determined to be about 2.7 billion years old, or roughly

34.6 million times older than Dick Clark. But even at that depth, the Kola project penetrated only into a tiny fraction of the continental crust, which ranges from 20 to 80 kilometers thick. There are still many secrets waiting to be discovered in Earth's dark and deep places.

Research is ongoing at the Kola Superdeep Borehole, which is now known as the Deep Geolaboratory. The huge repository of core samples is housed at Zapoljarniy, about ten kilometers south of the borehole. Today the site is managed by the State Scientific Enterprise on Superdeep Drilling and Complex Investigations in the Earth's Interior.

The heat and pressure caused the rocks to behave more like a plastic than a solid, and the rock surrounding the hole had a tendency to ooze inward whenever the drill bit was pulled out for replacement.

KOWLOON: THE WALLED CITY OF DARKNESS

A canker sore on the glittering metropolis of Hong Kong

In 1898 China agreed to lease its New Territories to Britain for a term of 99 years. However, like any lease, there was fine print. The agreement stated that China would keep control of a small, walled-in portion of the Kowloon Peninsula for use as a military installation. In 1899, shortly after the inception of the lease, Britain broke its agreement and took over the Kowloon region, motivating the Chinese officers stationed there to flee. Later that year the British also vacated the peninsula, and while the patch of land remained in their control technically, it was left void of any authority or governance. This forgotten and unruly enclave in Hong Kong became known as the notorious Kowloon Walled City.

In time, this 6.5-acre scrap of earth would become home to more than 40,000 people and by 1987 was regarded as host to the highest population density on Earth. Its citizens lived free from the laws created outside its walls, and Kowloon became a lost world of illegal immigrants and ruling crime lords. The cavernous alleyways and tightly packed structures kept many of the residents in darkness, earning the city the name "Hak Nam" or "City of Darkness."



■ As Kowloon's population grew and building increased, the city became virtually monolithic.

Those residing within the overcrowded city made a life of their own, creating businesses without regard to taxation or zoning laws. No health codes regulated the restaurants. Dentists practiced without licenses. One could scarcely swing a dead cat without hitting a casino or a brothel. Inhabitants had to fend for themselves, often wiring their own telephone lines, engineering a latticework of plumbing, and occasionally resorting to



■ Kowloon was notorious for its plethora of brothels, casinos, drug dens, and secret factories.

digging wells. Although the walls around the city were removed by occupying Japanese forces during World War II, the Chinese who did not already live within Kowloon were often kept out. Tourists were warned by police never to enter the squalor of the opium dens and damp corridors, which fueled the urban lore described by outsiders.

An apartment in Kowloon would make any freshman dorm room look palatial. At the peak of the city's population—40,000 souls—each resident had a living area smaller than a typical parking space. Despite the conditions, some residents found the lack of regulations favorable: An unlicensed herb-alist paying no taxes and minimal rent could treat patients and earn \$2,000 a month.

Amid the anarchy of Kowloon, organization and self-regulation naturally began to arise. The

city created schools, kindergartens, bakeries, and butcher shops all bearing a resemblance to the lawful society outside the city's boundaries. Some residents even made a living cleaning others' chamber pots every morning.

For decades it remained unresolved whether the city belonged to Hong Kong or to China. For those within Kowloon the debate was of little importance, as it had no bearing on their basic survival. Yet for all these citizens, this world would eventually come to an end.

With the stroke of a pen, Britain's Prime Minister Margaret Thatcher signed the sovereignty of Hong Kong to the communist Chinese. In 1987 the Chinese government exercised its authority to announce an evacuation of all residents of the Walled City of Kowloon and the future demolition

of the city. The Hong Kong government paid \$384 million in compensation to the 900 businesses and 10,700 households that would have to resettle.

For some it meant the end of an era of darkness and filth that the outside world had come to know as the "cancer of Kowloon."

For others, the forced evacuation presented the challenge of building a new life and new livelihood. The unlicensed professionals within the walls of the city would have to develop new job skills and new ways to live. Real estate brokers from inside the walled city had to forsake their old contacts and knowledge, and were left feeling tiny and alone in the sprawling landscape of Hong Kong.

The eviction of all the residents took years. Over time they accepted the government's payments and stepped out of the shadows. From 1988 to 1992, the dark corners of the housing units emptied; finally the most stubborn of the city's population were gathered and forced out by 150 armed police officers.

One particularly recalcitrant old man was said to have stood on the edge of a rooftop threatening to commit suicide if not permitted to stay. In the end, he was convinced to come down. Another local, a surly 62-year-old prostitute, refused the settlement because she was unsatisfied with the new apartment she was issued by the government. Many felt that the compensation they were offered was a pittance compared to the unregulated tax-free haven Kowloon had offered them. Moreover,

the announcement of the imminent demolition had prompted the city's crime lords to seek more lucrative locations elsewhere, making Kowloon's final few years its most harmonious.

At the peak of the city's population—40,000 souls—each resident had a living area smaller than a typical parking space.

By January of 1993, the city had been emptied and was prepared for demolition. Late one afternoon the sun set for the last time on Kowloon. With the electricity disconnected and the wells covered, the "City of Darkness" disappeared into the shadows of its darkest hour. For the first time the abandoned rooms and alleyways stood silent before the roar of demolition teams ushered in a new era.

Eventually the black and gray tones of the urban outpost were replaced with lush green hues of a city park. Grass and trees now stand on the scrap of earth where thousands of crime lords, prostitutes, bakers, artists, and others had once plied their trades for a tightly knit anarchic society. The dark, buried passages of the Walled City served to inspire writers and artists worldwide, proving once again that the darkest corners of the imagination often have their roots in reality.

THE LAKE PEIGNEUR DISASTER

Over the course of three hours, Lake Peigneur was transformed from a placid 11-foot-deep lake into a swirling vortex of doom

Early in the morning on November 21, 1980, a dozen Texaco-hired workers abandoned their oil-drilling rig hastily in the middle of a lake. They had been probing the floor of Lake Peigneur in Louisiana when their drill suddenly seized up at about 1,230 feet below the muddy surface. When they attempted to work the big drill loose—normally a fairly easy task at such shallow depths—the men heard a series of loud pops, and the rig tilted precariously toward the water.

In those days, Lake Peigneur was an unremarkable body of water near New Iberia, Louisiana. Though the freshwater lake covered 1,300 acres of land, it was only 11 feet deep. Its small Jefferson Island boasted a beautiful botanical park, and a few oil wells dotted the landscape. The area was also home to the Diamond Crystal salt mine, with miles of tunnels honeycombing the natural salt dome beneath the lake.

When the \$5-million drill rig began to buck and protest, the crew concluded that something had gone terribly wrong. They released the attached barges, scrambled off the rig, and moved to the shore about 300 yards away. Shortly after, the team watched in disbelief as the huge platform and derrick rolled over slowly and disappeared into a lake that was supposed to be shallow. Within moments the surrounding water began to rotate around the spot where the derrick had disappeared. The movement was almost imperceptible at first, but accelerated gradually into a fast-moving whirlpool with its center directly over the drill site. As the men looked

on, dumbfounded, the whirlpool grew to a quarter of a mile in diameter.

Down in the Diamond Crystal salt mine, an electrician named Junius Gaddison heard a series of loud clanging sounds from a nearby corridor. When he investigated, he discovered a knee-deep rush of muddy water dragging fuel drums down the mine shaft. He called in the alarm and headed for the nearest exit.

In the depths of the mine, the morning shift was interrupted when all the lights flashed three times, the signal to drop everything and evacuate immediately. The 50 or so miners—most of them working more than 1,500 feet underground—were quick to comply, hurrying to the higher levels to reach the elevators. When they got up to the third level, however, the route to the lifts was blocked by the rising waters.

From the surface, the cause of the unfolding disaster was unmistakable. Although the drillers had been aware of the Diamond Crystal salt mine, due to some miscalculation they had bored

straight into one of the cavernous 80-foot-high, 50-foot-wide upper shafts. As the lake drained into the mine through the 14-inch-wide borehole, the water dissolved the salt rapidly, widening the hole by the second. The water also began to eat away at the huge salt pillars that supported the mine's high ceilings. As the bases of the columns dissolved, many of them buckled. The upper shafts of the mine began to collapse.

As most of the miners rushed for the exit, a maintenance foreman named Randy LaSalle drove around to the remote areas of the mine that hadn't seen the evacuation signal and warned the miners there to evacuate. On level three, where high waters had blocked the escape route, the desperate miners used mine carts and diesel-powered vehicles to push their way through the water. Once the 50 miners reached the 1,300 foot level, eight men crammed into the elevator and began the excruciatingly slow journey to the surface. The lift

car then crawled back down the shaft to pick up another load of workers as the mine below filled slowly with water.

As the lake drained into the mine through the 14-inch-wide borehole, the water dissolved the salt rapidly, widening the hole by the second.

Meanwhile, up on the surface, the whirlpool's tremendous sucking power was causing violent destruction. Another drilling platform on the lake was swallowed whole, and a loading dock was ripped to pieces. Seventy acres of Jefferson Island was slurped into the vortex, including trees, structures, and a parking lot. The suction was so strong that it



Jefferson Island lost 70 acres of land and several structures to the maelstrom.

reversed the flow of a 12-mile-long canal that led out to the Gulf of Mexico, dragging 11 barges from the canal into the lake and down into the flooded mines. A tugboat on the canal fought against the current at full power, but its puny engines were no match for the maelstrom. After a prolonged struggle, the sailors brought their boat along the canal bank and made a jump for it, then watched as the whirlpool consumed their vessel.

After three hours, the lake was drained of its 3.5 billion gallons of water. The canal continued to draw salt water in from the Gulf of Mexico, forming a 150-foot waterfall into the muddy crater where the shallow lake had been. As the lake bed filled with ocean water, large pockets of trapped air escaped from the mine through the original drain hole, causing tremendous 400-foot geysers. Over the next couple of days, as the lake level reached the original waterline, nine of the sunken barges popped back to the surface like corks. The drill-

ing rigs and tugboat were never seen again, forever entombed in the ruined salt mine.

Despite the enormous destruction of property, no human life was lost in the Lake Peigneur disaster, nor were there any serious injuries. Within two days, what had previously been an 11-foot-deep freshwater body was replaced with a 1,300-foot-deep saltwater lake. The lake's ecology was changed drastically, and it became home to many species of plants and fish that had not been there previously.

Numerous lawsuits were filed, of course; they were subsequently settled out-of-court for many millions of dollars. The owners of the Diamond Crystal salt mine received a combined \$45 million in damages from Texaco and their oil-drilling contractors, and they got out of the salt-mining business for good. No *official* blame for the miscalculation was ever assigned, unfortunately, because all of the physical evidence was sucked down the drain.

LeMESSURIER'S MESS

A construction oversight makes a skyscraper perilously vulnerable to the wind

With its distinctive 45-degree diagonal crown, the Citicorp building is one of the most recognizable skyscrapers in the New York City skyline. At 59 stories, it's the third-tallest building in midtown Manhattan, and at the time of its completion, it was the seventh-tallest building in the world. At ground level, the huge skyscraper almost seems to hover above Lexington Avenue, held aloft by four massive, 114-foot-tall columns. Curiously, these columns are not situated at the building's corners, but rather are located on the center of each side. This unusual architecture was required to leave room for the preexisting St. Peter's Church. But little did the architects and engineers know that their design included a potentially catastrophic engineering flaw that went completely unnoticed during its construction and initial use.

The building's structural skeleton was designed by an engineer named William J. LeMessurier—pronounced “La Measure”—in the early 1970s. Making room for St. Peter's Church was a difficult problem, but LeMessurier was a highly capable and creative engineer. His design called for the building to sit atop four nine-story-tall stilts, one centered on each side. The structure's frame was designed with a specific geometry that would compensate for the oddly placed support columns. The design also called for a single, narrower column in the center, which housed the building's elevator banks and provided additional strength. This building shape made room for the church which stood under the building's northwest corner and gave the giant

structure a graceful, almost levitating appearance.

The concept itself was quite sound; in fact, it was elegant and technically brilliant. At only 25,000 tons, the steel superstructure of the building was remarkably light compared to other skyscrapers, such as the Empire State Building's 60,000-ton skeleton. LeMessurier also compensated for sway; all skyscrapers

■ The Citicorp building is held up by four stilts, one located at the center of each side of the skyscraper.



sway in the wind to some degree, but the stilted design and low weight of LeMessurier's design would have made the Citicorp building particularly nauseating on the upper floors. To combat this, his plans included a tuned mass damper: a 410-ton block of concrete housed in the upper floors of the building, floating on a thick film of oil and controlled by an automatic system. This substantial piece of stabilizing equipment would cut the building's sway in half by converting the kinetic energy into friction.

In 1978, about a year after the building's completion, an engineering student contacted LeMessurier to ask some technical questions about the architecture. The student's professor had expressed doubts regarding the strength of a stilted skyscraper where the support columns were not on the corners. "Listen, I want you to tell your teacher that he doesn't know what the hell he's talking about," LeMessurier told the student, "because he doesn't know the problem that had to be solved." He described the building's framing geometry in detail, explaining how it worked perfectly despite the oddly situated stilts. He also outlined how this design allowed the building to weather very forceful winds, even from a diagonal angle.

But the conversation got LeMessurier thinking, and he started doing some calculations to determine exactly how much diagonal wind the structure could withstand. He was particularly interested in the effects of an engineering change made during construction: Builders had opted to secure many of the structure's joints with bolts rather than the welds called for in the plans. Normally such a change was benign, but the Citicorp Center's design was unusually sensitive to diagonal winds. The results of his calculations were troubling.

Even a light wind imparts an enormous amount of force upon the broad, flat surfaces of a skyscraper, measuring in thousands or millions of pounds. A gust of wind pushing against a tall building has a great deal of leverage against its base, but gravity does most of the work in holding a building

together via compression. As long as the joints are strong enough to resist whatever wind force is not countered by gravity, the skyscraper is secure. LeMessurier's new calculations, however, indicated that the bolts in the Citicorp

Center's joints may not have been up to the task.

He brought his findings to fellow engineer Alan Davenport, an expert on the behavior of buildings in high-wind conditions. Davenport found that 70-mile-per-hour gusts would be sufficient to break the bolts holding the joints, resulting in catastrophic structural failure. Such winds were rare in New York, but not unheard of. Indeed, storms with such strength occurred about once every 16 years on average. Hurricane season was fast approaching, and only two men in the world knew that Citicorp's new \$175 million tower—and its thousands of occupants—could be toppled by nothing more than a stiff gust of wind.

Horrified, LeMessurier fled to his island hideaway on Sebago Lake to refine the calculations and consider his options. If he took personal responsibility for the profound error, he would be subject to litigation, financial ruin, and professional disgrace. If he kept the information to himself, thousands of lives would be in grave peril. He contemplated suicide as an alternative.

The following day LeMessurier decided to make some phone calls. He delivered the news to the corporate lawyers and consulted with Leslie Robertson, one of the designers of the World Trade

Only two men in the world knew that Citicorp's new \$175 million tower—and its thousands of occupants—could be toppled by nothing more than a stiff gust of wind.

Center. He then went to Cambridge to deliver the grim tidings to the building's architect, Hugh Stubbins Jr., who winced when he heard the news.

Together they flew to New York City to confront the executive officers of Citicorp with the dilemma. "I have a real problem for you, sir," LeMessurier said to Citicorp's executive vice president, John S. Reed. Stubbins and LeMessurier outlined the design flaw and described their proposed solution: to systematically reinforce all 200-plus bolted joints by welding two-inch-thick steel plates over them.

Work began immediately and continued around the clock for three months. Welders worked all night and carpenters labored during the day. In case of imminent disaster, an evacuation plan was put in place for the surrounding area, but the general public knew nothing of the circumstances. The press was on strike, so news of the repairs did not disseminate to the populace despite the flurry of unscheduled construction.

On August 30, 1978, Hurricane Ella formed over the central Atlantic and began to move toward Manhattan. Work crews had only finished about half of the welds necessary to secure the skyscraper. After a worrying few days, the massive storm veered to the northeast rather than testing the limits of the half-repaired building.



The distinctive 45-degree diagonal crown of the Citicorp building in New York City.

The welding was completed by September, at which time the engineers carefully reevaluated the entire structure. With its array of newly reinforced joints, the building was found to be one of the most sturdy skyscrapers in the world. Despite the successful resolution, the crisis was kept hidden from the public for almost 20 years, until an article appeared in *The New Yorker* in 1995.

As for LeMessurier, the executives at Citicorp asked no more than the \$2 million his insurance policy covered, despite the fact that the repairs alone cost over \$8 million. It is generally thought that his forthrightness so impressed the executives that they decided to keep their lawyers at bay. Certainly it takes a lot of character to admit one's

own mistakes, but by accepting personal responsibility for the flaw and leading the repair effort, William J. LeMessurier demonstrated an integrity that bordered on the heroic.

Unfortunately, the amount of damage that could be caused to New York City by a falling skyscraper is now known all too well, but in 1978 the idea was still unthinkable. Had this engineering gaffe not been accidentally discovered and quickly resolved, something as seemingly harmless as a stiff gust of wind might have toppled one of Manhattan's tallest structures.



THE MAD GASSEER OF MATTOON

A mysterious figure fumigates an unwitting Illinois town

On September 2, 1944, as World War II raged in Europe and the Pacific, some strange happenings were reported in the quiet town of Mattoon, Illinois. The front page of the town's newspaper, the *Daily Journal-Gazette*, described a mysterious attack by an "Anesthetic Prowler" the previous evening. A young housewife named Aline Kearney had been lying in bed reading the newspaper when she noticed a strong, sweet odor seeping into the room. The smell made her and her three-year-old daughter feel ill, but when Aline tried to get out of bed, she found that she couldn't move her legs.

Aline's sister was staying at the house, and upon hearing Aline's panicked calls and smelling the gas herself, she dashed to a neighbor's house to have them contact the police. When the police investigated they found nothing out of the ordinary, but when Aline's husband arrived home later that evening, he discovered a prowler outside the bedroom window. He gave chase, yet the unidentified lurker escaped. The police were summoned back and their search was once again fruitless. Real or imaginary, the dark figure would soon come to be known as the "Mad Gasser of Mattoon" and he would be accused of dozens of similar attacks in the days to come.

The following day's newspaper proclaimed "Anesthetic Prowler on Loose." Beneath the headline, the subheading declared ominously, "Mrs. Kearney and Daughter First Victims." In using the term "first," the *Gazette* reporters seemed to demonstrate either a flair for the dramatic or an uncanny predictive ability; in the days after the news report, three other citizens came forward claiming that

they had been the victims of "gassings" before the incident at the Kearney house. Complainants spoke of lightheadedness, paralysis, upset stomach, and vomiting, all associated with the onset of a sickly-sweet odor.

A few days later, on September 5, Mrs. Carl Cordes reported finding a small scrap of wet cloth on her porch. She picked it up and was overcome by an odor. "It was a feeling of paralysis," she reported. "My husband had to help me into the house, and soon my lips were swollen and the roof of my mouth and my throat burned. I began to spit blood and my husband called a physician. It was more than two hours before I began to feel normal again." Detectives found the rag on the Cordes's porch and a well-worn skeleton key on the ground nearby, but they couldn't detect any trace of noxious substances on the offending cloth.

For months, the U.S. news media had been warning Americans that the Nazis might employ poison gas in attacks against civilians. Jittery citizens,

eager to confirm their fears, snapped copies of the *Gazette* off the shelves in throngs. On September 8, the paper published a scathing editorial criticizing police for not taking the report of Aline Kearney—the mysterious gasser's first confirmed victim—more seriously. Shortly thereafter, ten Illinois state police officers were assigned to the case, along with two FBI agents.

Before long, police began to receive reports of several attacks each night. Many victims reported blue vapors and buzzing sounds in their homes, as well as a slender black-dressed figure fleeing from their property. Victims experienced a gamut of symptoms, including swollen lips, vomiting, and paralysis. Where each attack occurred, the *Daily Journal-Gazette* was sure to be close behind.

Many victims reported blue vapors and buzzing sounds in their homes, as well as a slender black-dressed figure fleeing from their property.

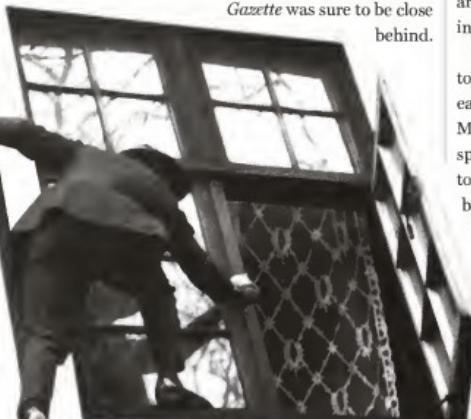
Perhaps emboldened by the attention from the press, the shadowy attacker's tactics became more aggressive. Police found slits in the screens of some victims' homes, and some complainants reported that the gassy stranger had clambered boldly in through a window. By some accounts he came armed with a handheld insecticide sprayer, pumping its plunger to squirt his sickly-sweet vapors.

The Mattoon gas attacks were eerily similar to a rash of incidents that had occurred a decade earlier in Botetourt County, Virginia. There, as in Mattoon, a man in dark clothes was allegedly seen spraying objectionable chemicals into the homes of townsfolk. The perpetrator had never been found, but plenty of physical evidence supported the victims' claims. The Virginia incidents had not been widely publicized, however, so it was unlikely that any of the Mattoon victims were aware of the prior gassings.

As the frequency of Mad Gasser reports continued to increase, including some of a rather dubious nature, the Mattoon City Commissioner of Public Health addressed the issue. "There is no doubt that a gas

maniac exists and has made a number of attacks," he stated, "but many of the reported attacks are nothing more than hysteria. Fear of the gas man is entirely out of proportion to the menace of the relatively harmless gas he is spraying. The whole town is sick with hysteria."

Unsatisfied with the authorities' response, large groups of armed residents began roaming the town at night. Each time a police officer raced to



Their reporters earnestly gathered the facts and imparted the tales to an increasingly panicked citizenry. National news outlets picked up the story, and soon the entire country was engrossed by the odd goings-on in Mattoon.

■ Who was Mattoon's Mad Gasser?
A man, woman, or figment of the town's imagination?

the scene of an attack with sirens blaring, the vigilante gang was close on his heels. Police officers were ordered to start arresting the armed civilians. Tensions mounted.

On Sunday, September 10, Mattoon police questioned four suspects and arrested one: a local fellow named Farley Llewellyn. The young man had once been a gifted student of chemistry, but his alcoholism, strange mannerisms, and unfashionable sexual orientation had ensured that he was ostracized by the community. Most of the alleged attacks occurred near his home, where he had been rumored to spend much of his time tinkering in his makeshift chemistry lab. But the night after he was placed in custody, the police were forced to release him when a Mattoon resident once again spotted a prowler toting spraying apparatus. This sighting differed a bit from the others, however, as the gasser was described as a short, plump person. At the scene, detectives discovered a set of fresh footprints from a woman's high-heel shoes.

The mentally troubled young man had the motive and the means to terrorize his neighbors with exotic chemicals.

Police were prepared to continue their search for the gas maniac, but on September 13, the reports of attacks halted abruptly. After two weeks and three dozen victims, the mysterious attacker had apparently holstered his spray gun for good. The police investigation petered out due to lack of leads, and the town gradually returned to normality.

In the intervening years a number of theories have been put forward to explain the phenomenon that struck so much fear into the small Illinois community. The official investigation at the time ultimately dismissed the Mad Gasser as an artifact of mass hysteria. Most modern historians and psycholo-

gists tend to agree. Humans have a habit of placing too much trust in their far-from-perfect senses and emotions, allowing individuals to convince themselves of irrational things. When the Mattooners' Nazi-gas paranoia was reinforced by fantastic stories from the press, the townsfolk naturally became predisposed to seeing gas maniacs lurking in the shadows. Additionally, the victims' swelling, vomiting, and other physical symptoms might have been brought about by nothing more than the fear of harmful chemicals, a well-documented phenomenon known as the "nocebo effect."

Some historians have postulated that pollutants from nearby industrial plants may have been the source of nausea-inducing gases, even if the gasser himself was a product of hysteria. However, the police officers and FBI agents at the time scoured the local factories for potential culprit chemicals and turned up only scant amounts. It is also unlikely that industrial pollution would find its way into only a few specific homes each night.

There are some who still believe that the Mad Gasser of Mattoon was a real flesh-and-blood villain: Farley Llewellyn. The mentally troubled young man had the motive and the means to terrorize his neighbors with exotic chemicals, and with one notable exception, the attacks halted immediately after his arrest. Considering the unusual physical description of the final sighting and the female footprints found at the scene, it has been suggested that one of Llewellyn's "unkempt and reclusive" sisters may have assumed her brother's spray gun in an attempt to exonerate him. Regardless of his true role in the incidents, Farley Llewellyn's family committed him to a mental institution shortly after the Mad Gasser's final public appearance.

None of the victims experienced any lingering symptoms from their brush with the Mad Gasser, but the people of Mattoon would not soon forget. Whether the incidents were the fruit of a mad scientist or merely hysterical vapors, it is unlikely that we will ever know.

MAD JACK CHURCHILL

An indomitable warrior carries a sword into World War II

In 1940, the German commanders overseeing the push into France began to receive strange reports from the field: Seemingly at random, bodies were turning up that appeared to have been pierced by broad-head arrows or hacked with a basket-hilted claymore sword. In a war of rifles, artillery, and tanks, such injuries were obviously out of place and even a little bit daunting for the close, personal combat they implied. These strange casualties were the calling cards of Captain Jack Churchill.

Jack Malcolm Thorpe Fleming Churchill was born on September 16, 1906, in Hong Kong to English parents, and lived his entire life with an affection for all things Scottish. A lifelong soldier, Jack knew no fear, and in fact thrived on violence. He graduated from the Royal Military Academy at Sandhurst in 1926 and was commissioned to the Manchester Regiment, but he left the army in 1932, exasperated by the seemingly endless stretches of peacetime in Europe. He spent his idle time mastering the bagpipes, a pastime considered quite unusual for an Englishman. Nevertheless, it was a pastime at which he excelled.

His leisure came to an end with Germany's attack on Poland. Jack promptly reenlisted and was assigned back to the Manchesters. He entered into combat with the rest of his regiment, but with an important difference: Jack insisted upon carrying a bow, sword, and arrows with him.

His name, being a bit of a mouthful, was abbreviated by his comrades to "Fighting Jack Churchill" or sometimes just "Mad Jack." When the English put out a call asking for commando volunteers, Jack didn't know what a commando was, but hearing it would involve more action, he signed up.

While training for the commandos, Jack became famous among his fellow trainees for playing his bagpipes at 3 A.M., scolding sloth, and delivering ad hoc speeches such as: "There's nothing worse than sitting on your bum bottom doing nothing just because the enemy happens to leave you alone for a moment while he has a go at the unit on your



■ Playing the bagpipes was one of Mad Jack's favorite pastimes.

flank. Pitch in and support your neighbor any way you can!"

Mad Jack finished his commando training in 1940, and one of his first missions was to lead the Manchesters on an ambush against a Nazi patrol near l'Epinette, France. As his fellow soldiers remained out of sight, Jack crept to a favorable position, set aside his gun, and notched a barbed arrow onto his longbow. He pulled back the string and let the arrow loose, piercing the German sergeant and signaling the Manchesters to open fire. Hence Mad Jack became the first and only British soldier in the course of the war to kill an enemy with a bow and arrow.

"In my opinion, sir, any officer who goes into action without his sword is improperly dressed."

In December 1941, as the Manchesters attacked a German-controlled beach in Norway, Jack once again secured his infamy by standing at the bow of the lead craft while playing "March of the Cameron Men" on his bagpipes. As his craft landed on the beach, he leaped from the boat, threw a grenade, and headed for the bay at a full sprint. His report at mission's end was matter-of-fact: "Maaloy battery and island captured. Casualties slight. Demolitions in progress. Churchill."

In another attack, Mad Jack and one of his enlisted men managed to sneak up on a pair of German sentries making rounds. He leapt at the unsuspecting soldier, sword in hand, and shouted, "*Hände hoch!*" The Germans obeyed, dropping weapons and raising their hands. Jack's enlisted companion escorted one of the prisoners back to camp. Jack, meanwhile, wrapped his belt around the other sentry's throat and headed farther into German territory. At each guard post Jack's prisoner would say something to lull the guards into complacency, at which point a

mustached madman with a sword would jump out and order them to drop their arms. All in all, 42 German prisoners were captured that night.

In 1944, Jack's luck took a slip when he was ordered into an impossible situation. Most of his squad was killed, and Jack was taken captive. After being hauled to Berlin for questioning, he was sent to a concentration camp at Niederdorf, Austria, where he was meant to stay until war's end. He might have done so, but when the power went out one night, Jack was prepared: He had a rusty can and some onions. It was all that he needed. In the darkness and confusion, he simply slipped away from the guards and walked out of the camp.

The rusty can became a cook pot for the vegetables he liberated from the Nazis along his journey. Jack stayed off the road to avoid detection, and held a steady route south until he encountered a column of tanks bearing the white star of the U.S. Army. By the time he stepped out of the brush and snapped out a brisk Sandhurst salute, he'd been free for eight days and had walked 150 miles.

Churchill was soon back in service, but by then the war in Europe had almost ended. Never one to let circumstances get him down, Jack asked to be put back in action, noting hopefully, "There are still the Nips, aren't there?" By the time he was redeployed, however, the atomic bomb had been dropped and the war was over.

Mad Jack continued in the army until 1959, qualifying as a paratrooper and serving in the Palestine conflict. Even in retirement his eccentricities continued. On his train rides home each day, he frequently startled train conductors and passengers by throwing his attaché case out of the train window. Before he died in 1996, he explained that he was tossing his case into his own backyard so he wouldn't have to carry it from the station. It must have seemed like a perfectly reasonable thing to do for a man who once said, "People are less likely to shoot at you if you smile at them," and "In my opinion, sir, any officer who goes into action without his sword is improperly dressed."

THE McCOLLUM MEMO

A declassified document suggests that perhaps Pearl Harbor wasn't really a surprise attack

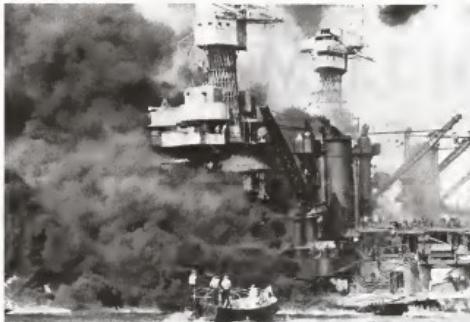
In the 1930s, citizens of the United States were struggling under the crushing burden of the Great Depression. President Roosevelt's "New Deal" had brought some relief through the creation of Social Security and the Securities and Exchange Commission; however, jobs remained scarce and manufacturing was dismal. As Europe began once again to see the shadow of war, the people of the U.S. were discordantly uninterested in becoming entangled in yet another European conflict. In 1937 the U.S. initiated the Neutrality Act, a law preventing the United States from shipping arms to any combatant nation. Later, Roosevelt's Quarantine Speech instructed the people of the world to treat aggressive nations as plagues, solidifying the public's isolationist mentality.



■ Did Roosevelt know of McCollum's Memo?

Within that same month, however, the President ordered an increase in naval ship and submarine production, just in case they were needed to blockade Japan. There are people who believe that while FDR preached peace to the world, he was also wishing secretly for a war to usher out the Depression. War, as they say, is good for business.

By 1940 the new World War was going strong as America maintained its distance. Only the massive USSR separated the Axis powers in Europe from their Japanese cohorts—and military intelligence suggested that the Russians were leaning toward the Axis objective. If the USSR did join the war on the side of Germany, Western nations feared that most of the world would be quickly lost to the Axis Powers. While strong sympathies and



■ Some historians suggest that the attack on Pearl Harbor was a direct result of the actions recommended in the McCollum Memo.

stronger sentiments were expressed in the United States, most of the population supported continued isolationism. Agents of the federal government, unable to go against public sentiment and unwilling to be left out of such world-altering events, did all they could to balance the will of the people with the thirst for war. In September 1940, President Roosevelt entered into the Destroyers for Bases Agreement, which allowed the U.S. to give military vessels to England in exchange for use of English-controlled bases worldwide. Later that same month, Roosevelt passed the Selective Training and Service Act—a bill that basically constituted a peacetime draft: All men aged 21 to 30 were required to register with local draft offices in preparation for war.

On October 7, 1940, Lieutenant Commander Arthur McCollum in the Office of Naval Intelligence delivered a memo to captains Walter Anderson and Dudley Knox, two of Roosevelt's trusted military advisors. The memo was essentially a "recipe for war," containing a breakdown of the current war situation and a checklist of eight things that the United States could do if it wished to provoke an attack from the Empire of Japan and thereby gain public support to join the war. "If by these means

Japan could be led to commit an overt act of war," the memo stated, "so much the better."

Whether or not Roosevelt was aware of the McCollum Memo, he soon seemed to be following its instructions to the letter. The document described a series of measures that were specifically designed to irk the Japanese:

It is not believed that in the present state of political opinion the United States government is capable of declaring war against Japan without more ado; and it is barely possible that vigorous action on our part might lead the Japanese to modify their attitude.

Therefore, the following course of action is suggested:

A. Make an arrangement with Britain for the use of British bases in the Pacific, particularly Singapore.

B. Make an arrangement with Holland for the use of base facilities and acquisition of supplies in the Dutch East Indies.

C. Give all possible aid to the Chinese government of Chiang-Kai-Shek.

Roosevelt was elected to his third term in the White House on November 5, 1940. While campaigning, he promoted himself as the candidate of experience and claimed that he would make every effort to keep the U.S. out of the war. Soon after being reelected, however, Roosevelt signed the Lend Lease Act—another bill that supplied Allied nations with war matériel in exchange for the use of various bases around the world. This put a U.S. Navy presence in Newfoundland, Bermuda, and the British West Indies. When Japan redoubled its invasion of China in July 1941, the Lend Lease Act was expanded to send aid to China as well. Over the following year, the United States' measures eerily continued to mirror McCollum's eight-point plan:

“D. Send a division of long-range heavy cruisers to the Orient, Philippines, or Singapore.

E. Send two divisions of submarines to the Orient.

F. Keep the main strength of the U.S. fleet now in the Pacific in the vicinity of the Hawaiian Islands.

G. Insist that the Dutch refuse to grant Japanese demands for undue economic concessions, particularly oil.

H. Completely embargo all U.S. trade with Japan, in collaboration with a similar embargo imposed by the British Empire.”

Japan was receiving 80 percent of its oil from the United States when the embargo was enacted. Without the fuel from the U.S., Japan was in a dire situation. Japan's oil-thirsty war machine made them desperate, and the U.S. presence in the Philippines looked like they were prepared to keep Japan from getting oil from other sources.

The memo was essentially a “recipe for war,” containing a breakdown of the current war situation and a checklist of eight things that the United States could do if it wished to provoke an attack from the Empire of Japan.

That same summer, the U.S. committed “all aid short of war” to the Allied powers. The Pacific Fleet was moved from San Diego to Pearl Harbor, just as McCollum's memo recommended. Command of the Pacific Fleet was offered to Admiral Chester W. Nimitz; however, he declined the post, noting that he didn't want to become a scapegoat if or when the Japanese surprise attack arrived. Admiral Husband E. Kimmel was given the assignment instead.

On December 4, 1941, the *Chicago Tribune* reported on “Rainbow 5”—a U.S. Navy plan detailing the way in which the United States would enter the war. It could rightfully be argued that such a plan was merely prudent contingency planning, but little arguing occurred, since only three days later, Japan did attack Pearl Harbor. In addition to killing more than 1,200 Americans, the attack ended the isolationist mentality that held the U.S. at bay, and people all over the country demanded to join in the World War.

There is no direct evidence that Roosevelt ever saw or acted upon the McCollum Memo, nor that it influenced the U.S. Senate in any way. Yet in 1955, Admiral Kimmel released an autobiography in which he wrote that Roosevelt hungered for war, and that his own position and career were sacrificed. He claimed that he had been blamed for Pearl Harbor despite the fact that the President allegedly knew exactly what was coming.

When McCollum's eerily prognosticating memo was declassified and released under the Freedom of Information Act in 1994, it included a page appended by Captain Dudley Knox, one of Roosevelt's top military advisors. He wrote:

“It is unquestionably to our interest that Britain be not licked—just now she has a stalemate and probably can't do better. We ought to make certain that she at least gets a stalemate [...] I concur in your courses of action. We must be ready on both sides and probably strong enough to care for both.”

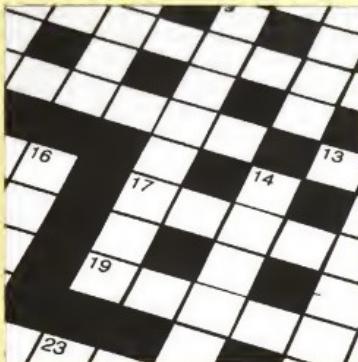
While there is no solid proof, it's not difficult to make a circumstantial case that shows the U.S. baited the Japanese deliberately to draw the country into World War II—all elements of McCollum's eight-step anti-neutrality program were enacted in the months prior to that day that will live in infamy. The war economy indeed proved to be the killing stroke to the last lingering vestiges of the Great Depression.

THREE LETTERS, PROFESSIONAL SUBTERFUGE ARTIST

In wartime Britain, the newspaper crossword was a welcome daily respite from the stress of the ongoing conflict. In the spring of 1944 this was especially true for the officers of MI5, who were charged with the immense task of keeping secret the upcoming Operation Overlord D-Day landings. The security agency therefore took notice when the word "Utah"—code name for one of the five beaches chosen for landings—appeared as a solution in the May 3, 1944, *Daily Telegraph* crossword, little more than one month before the liberation of Nazi-occupied northern Europe was due to begin. It seemed possible that a spy was at work, feeding information to the Germans through the daily puzzle. On further reflection, the officers realized that the names of three more invasion beaches—"Juno," "Gold," and "Sword"—had also appeared in the same crossword over the past few months. Now puzzling with a keen professional interest, on May 22 the officers spotted "Omaha" in the day's crossword conundrum: the fifth and final beach code name. Then, alarmingly, the men found themselves filling in the letters "Overlord" in the May 27 crossword and "Mulberry"—the name of the massive floating harbors to be used in the landings—on the 30th. Treachery seemed more and more likely.

On June 1, the code name of the operation's assault phase, "Neptune," appeared as a solution. With D-day less than a week away, MI5 had to act. It dispatched two men to the home of Leonard Dawe, the 54-year-old school headmaster who compiled the crossword. During the several hours of harsh interrogation that followed, the schoolmaster denied everything, insisting tremulously that he had the right to use whatever words he chose. Eventually, the officers grew satisfied that the stubborn schoolteacher knew nothing of the coming invasion. It had all been a stupendous coincidence.

That, at least, was the story as it was known for the next 40 years. In 1984, a former wartime student of Dawe's came forward with what he claimed to be the rest of the tale. Reportedly, Dawe would occasionally invite his students to help fill in his blank crossword grids as an academic exercise. Near the school was a military camp where Canadian and American soldiers could be heard chatting idly about the upcoming mission. It seems that MI5 had been whipped into a panic due to a nosy 14-year-old boy named Robert French. The student had overheard some intriguing words in officers' conversations and slipped them into the crosswords under his teacher's unwitting eye.



■ Was a puzzle like this the site of coded messages during World War II?

MIKE THE HEADLESS CHICKEN

A man's attempt to procure a chicken dinner instead produces an amazing—and profitable—miracle bird

On September 10, 1945, Clara Olsen was having her mother over for dinner, so she dispatched her husband, Lloyd, to fetch a chicken for frying. He grabbed a small ax and headed out to the coop on his small farm in Fruita, Colorado. Olsen selected a delicious-looking five-and-a-half-month-old rooster and set him on the block. Knowing that Clara's mother was fond of crispy fried chicken neck, Lloyd held the condemned fowl firmly and aimed the killing stroke to leave as much neck as possible. With a well-practiced hand, Lloyd heaved back and struck off the rooster's head.



■ Mike the headless chicken (left), and Mike, the chickenless head (right).

In his years of slaughtering chickens, Lloyd was accustomed to seeing them run a few circles before they fell down and stopped thrashing, but this particular bird stood up, puffed out his feathers, and staggered back into the coop. Inside, the headless rooster started hopelessly making the motions of pecking for corn and preening. Lloyd scratched his head and went back in the house, figuring the bird would eventually drop dead.

The next morning Lloyd headed to the coop to find the decapitated rooster huddled in a corner with his neck stump tucked under a wing, resting but still very much alive. He reasoned that if a bird had that much will to stay alive, then it was his duty to help. Rather than receiving a dose of flour and a bath in cooking oil, the rooster got a name and a publicity agent as he toured the country as "Mike, the Miracle Chicken."

Though Mike tried valiantly to feed himself, he relied on his human handlers to insert kernels of corn and drops of water into his exposed throat. He attempted to crow, but would emit only a strangled gurgle. A week after the beheading, Mike remained healthy and strong, so the enterprising farmer put the rooster's head in a jar and took the bird for a 250-mile trip to the University of Utah in Salt Lake City. There the bird was given over for examination, and the science staff listed his condition as "alive" and "headless." After studying the bird and his head for some time, the experts concluded that the bird had survived the chopping block thanks to the farmer's effort to preserve as much neck as

possible. Much of the brain stem still remained at the top of the neck, and since the common rooster doesn't use many higher brain functions, the loss of the cerebrum was not fatal.

The Olsens devised a way to keep the bird alive by feeding it a gruel of corn and grain, and they cleared out the throat regularly with a syringe so that Mike wouldn't choke on his own mucus. Normally the lack of a brain would hamper one's career options, but a local PR man named Hope Wade saw opportunity where others saw only oddity. Asking for just a small percentage of the profits, Wade sent the Olsens on a cross-country tour with "Miracle Mike the Headless Chicken." Setting up at various carnivals and festi-

vals, they charged two bits a head to gawk at the decapitated fowl.

The Olsens described Mike as "happy as any other chicken," and indeed, save for the red scab on his neck, he was so healthy that animal-rights activists found little reason to protest his treatment. There were, however, some unfortunate casualties when other residents of Fruita took the ax to their own hapless roosters in attempts to re-create the Olsens' \$4,500-a-month attraction.

Although he was unable to see, smell, or hear, Mike was able to visit places that few other chickens had dared to dream. He stopped by such locales as New York, Los Angeles, Chicago, and San Diego in the months after he lost his head. Oblivious to the crowds of awestruck onlookers, Mike strutted about and attempted to preen and peck corn with his unequipped neck. He was arguably the most famous bird of his time. *Life* magazine documented Mike in a series of photographs, and the Guinness World Records people



■ Feeding a headless chicken and keeping his airway clear requires constant vigilance.

HOW TO CHARM A CHICKEN

Eschewing modern technology and conventional bird husbandry methods, some traditional farmers promote the ancient and mysterious art of poultry stupefaction. A chicken's brain is small enough to be eclipsed by a dime and is therefore an easy subject for such techniques. The simplest of them—the Oscillating Finger Method—requires nothing more than an ordinary chicken and a human finger.

The chicken charmer starts by placing the bird on its side, with its head flat against the ground. The tip of a finger is positioned just in front of the chicken's beak, but without touching it, and repeatedly slid back and forth on the ground, along the line of the beak. The chicken quickly enters a trancelike state with significantly reduced heart and respiration rates, and can remain this way for anywhere from 15 seconds to several hours. Most of the time the bird normalizes within a few minutes, or it can be brought out of its daze prematurely with a loud noise or sudden movement. Practitioners of bird mesmerism are still trying to figure out a way to apply their techniques to headless subjects.

recorded his incredible survival. His plight even became the subject of a playground chant, as children sang, "Mike, Mike, where's your head? Even without it, you're not dead!"

Much of the brain stem still remained at the top of the neck, and since the common rooster doesn't use many higher brain functions, the loss of the cerebrum was not fatal.

Then one day, just after a carnival trip to Phoenix in March 1947, the Olsens were awakened in their hotel room by the sounds of panicked wheezing coming from Mike. There was a mad scramble to find the syringe used to clear foreign objects from

the famous chicken's throat, but it was nowhere to be found. As the Olsens looked on helplessly, their prize rooster asphyxiated on his own phlegm and died. Though Mike had put on a few pounds in the 18 months since he was beheaded, the Olsens didn't have the stomach to eat him.

Although Mike is dead, his legacy lives on even today. A larger-than-life statue of him stands proudly, and headlessly, in his hometown of Fruita, Colorado. Every summer, on the third weekend in May, the town holds a "Mike the Headless Chicken Festival" as tribute to the bird's inspiring will to live. It features events like a car show, a Chicken Dance contest, a 5k "Run Like a Headless Chicken," and a "good egg award." It may be the only place in the world where one can procure "chicken noodle soap." Ironically, the festival is famous for its fried chicken. As the festival's promoters proclaim, "Attending this fun, family event is a *no-brainer!*"

THE MOLASSES FLOOD OF 1919

After an explosion, a wave of brown sticky goo is unleashed on the unsuspecting citizens of Boston

On January 15, 1919, the ground near 529 Commercial Street in Boston, Massachusetts, began to tremble. At the nearby Purity Distilling Company, a six-story-tall molasses tank grumbled like a massive stomach with indigestion. The tank's monumental cache of molasses was awaiting transfer to a processing plant, where it would be used in the production of sweetener, drinking liquor, and alcohol-based munitions. Moments after the first distressed groan, a sound reminiscent of machine-gun fire echoed in the streets as the tank's rivets buckled in quick succession. The tank burst in a terrific explosion, throwing massive, ragged chunks of sheet-iron into the surrounding buildings. The Purity offices were flattened by the blast, and a nearby fire station was crushed by a flying section of the iron.

Despite the force of the rupture, initial damage was limited to the buildings adjacent to the tank. The two-and-a-half-million-gallon column of molasses, however, caused a considerable catastrophe as it spread itself out into the North End neighborhood. Bystanders were swept up in the smothering goo, tossed and rolled through the thick sludge. The migrating wave of brown syrup pushed buildings off their foundations and overturned wagons, carts, horses, and motorcars. It broke the girders of an elevated railroad and tossed a train from its tracks. Within minutes, several blocks of Boston's streets were filled with struggling victims, rubble of ruined buildings, assorted wreckage, and two to three feet of sweet, tacky goo.

Rescue efforts began immediately, but most who ventured in became mired in the mess and soon required rescuing themselves. Terrified survivors



■ Several blocks were flooded to a depth of 2 to 3 feet.



■ It took over 87,000 man hours to remove the molasses from the cobblestone streets, businesses, cars, and homes.

were seen running away from the chaotic scene covered from head to toe in dark-brown molasses. The U.S.S. *Nantucket* was anchored at the Playground Pier a few blocks away, and Lieutenant Commander H. J. Copeland sent over a hundred able-bodied sailors to lend assistance. Police officers, military personnel, and Red Cross nurses slogged through the knee-deep syrup all night long, searching for sticky victims.

In all, 21 lives were lost in the disaster—mostly due to crushing and asphyxiation—and 150 injuries were reported. It is said that a lawyer for Purity arrived on the scene within hours and tried to pin the disaster on anarchist saboteurs, but despite this continued insistence, the company ultimately paid out about \$1 million in settlements (equivalent to about \$11 million today). The nearby harbor remained brown through the rest of the winter and spring, and it took more than six months to clean the structures, automobiles, and cobblestone

streets of the sticky mess. By coincidence, the 18th Amendment of the U.S. Constitution was ratified the day after the catastrophe, paving the way for Prohibition.

The exact cause of the explosion was never determined, but it is generally attributed to high pressure and a defect in the tank construction. According to some reports, the Purity Distilling Company had neglected to pressure-test the vessel prior to filling it for the first time, and upon its first load of molasses, the outside of the tank was striped with molasses leaks. Rather than paying for repairs, Purity opted to paint the tank brown. On that fateful day in 1919, pressure increased due to fermentation of the molasses and unseasonably warm temperatures. This put too much strain on the existing fractures, causing an energetic rupture.

Although it's been almost a century since the flood, they say that on a hot day the streets in some parts of Boston still bleed molasses.

MONTAGU'S MANUFACTURED MAJOR

Beware the tales told by imaginary men

Early in the morning on May 1, 1943, a fisherman on a beach in Spain discovered a waterlogged corpse that had washed ashore sometime during the night. The dead man was clothed in British military attire and a life preserver, and he had a locked briefcase chained to his lifeless body. The corpse was transported to the local port in Huelva, and the obedient officials promptly reported the discovery to the Nazi officers stationed in the city.

From his personal effects, they were able to identify the man as Major William Martin, a temporary captain and acting major in the British Royal Marines. A hasty postmortem verified that he had drowned and that his body had been in the sea for several days before the tide deposited him upon the beach. Major Martin, it seemed, was a casualty of a British aircraft lost at sea. Rather than allowing possible military intelligence to go unintercepted, the local agents for the Abwehr—the German intelligence organization—coaxed the briefcase open to examine its contents. Inside, along with a number of everyday items, the Nazis discovered a personal correspondence between Lieutenant General Sir Archibald Nye, the vice chief of the Imperial General Staff, and General Sir Harold Alexander, the British commander in North Africa. Among other things, this letter discussed key details of the Allies' plans to invade Nazi-held territory. The accidental intelligence seemed to be strategically priceless, but the discovery would ultimately result in disaster for the Third Reich.

Within days, the Spanish government turned the body over to the British military, and Major Martin was buried with full military honors in Huelva. However, the British Admiralty had not received the Major's attaché case, and they made an urgent request for the return of the major's effects. The Admiralty emphasized the need for discretion due to the documents' sensitive nature. The government of Spain was compelled to comply because the country was technically a neutral party in the war, although it was sympathetic to the Nazi cause. The documents were returned to the British military 13 days later, but not before the German Abwehr agents teased open the sealed letters, photographed everything in the briefcase, and resealed the envelopes to alleviate suspicion that the letter's contents had been discovered. These photographs were then rushed to Berlin for thorough analysis.

Wary of a ruse, German intelligence examined the officer's effects for evidence of deception. The major's possessions included numerous benign items such as a photograph and love letters from his fiancée, a set

of keys, recently used ticket stubs for a theater performance, and a hotel bill. A close inspection and investigation strongly suggested that these items were genuine, indicating that Major William Martin and the documents found on his person were authentic. A second letter in the dead man's possession—this one from the Chief of Combined Operations to the Commander-in-Chief in the Mediterranean—even mentioned that Major Martin was carrying a letter too sensitive to be sent through normal channels, hence the need for him to fly.



■ The mastermind of the deception, Ewen Montagu.

The letter was indeed quite sensitive; it discussed key details of "Operation Husky," a secret Allied strategy to invade Nazi Europe by way of Sardinia, Corsica, and Greece. It also described a plan to prepare a false attack upon Sicily—the location where Germany expected the Allies to attack—as a way of drawing German forces away from the true invasion sites. Upon learning of the letter, Adolf Hitler took decisive action. On May 12, 1943, he sent out an order: "Measures regarding Sardinia and the Peloponnese take precedence over everything else." He diverted significant defenses away from Sicily to the indicated points of hostile ingress, including an

extra Waffen SS brigade, several Panzer divisions, patrol boats, minesweepers, and minelayers.

About two months later, the Allies attacked Sicily just as the letter said they would. But the invasion was far too well equipped to be a mere distraction. Even more troubling, all was relatively quiet on the beaches of Sardinia, Corsica, and Greece. The Germans had fallen for an elaborate deception designed to draw their defenses away from the true Allied target: Sicily. The intercepted correspondence was counterfeit, and the late Major Martin was an imaginary man.

The idea to plant false documents on a dead man and let them fall into German hands was conceived by Lieutenant Commander Ewen Montagu at British naval intelligence. Montagu's brilliant and elaborate death-at-sea ruse was dubbed "Operation Mincemeat." In order to maintain the illusion that the document-carrier had drowned, the naval intelligence team needed a recently deceased man who had died with liquid in his lungs. After combing through the Allied morgues and hospitals, the men located and secured the body of a 34-year-old civilian who had died while suffering pneumonia. The man's family granted permission to use the body on the condition that the man's identity never be revealed. As the body waited in cold storage, the fictional life of Major William Martin was fabricated in great detail by a section of British military intelligence called the Twenty Committee (often referred to by the Roman numeral XX or "double-cross"). The corpse was furnished with identification papers, keys, personal letters, and other possessions. In order to explain why Major Martin would be found chained to his briefcase, Montagu's team planted evidence suggesting that he was an absentminded but responsible chap, including overdue bills and a replacement ID card. Such a man might chain himself to a briefcase full of sensitive documents in order to prevent its loss during a flight.

On April 28, 1943, Major Martin was placed aboard the submarine HMS *Seraph* in a special steel

canister packed with dry ice. The crew set off for the coast of Spain, where it was likely that a citizen of the Axis-friendly country would find the body and report it to authorities. After two days at sea, the submarine surfaced about a mile off the coast of Spain at 4:30 in the morning. Members of the crew carried the heavy canister topside, having been told that it contained top-secret meteorological equipment. Everyone aside from the officers was ordered below deck. There in the darkness, the commander of the *Seraph* explained the mission and swore the men to secrecy. Major Martin's body was then removed from the canister onto the deck, where he was fitted with his life jacket and chained to his briefcase. The men read the 39th Psalm and committed the body to the sea, where the tide gradually nudged it ashore.

Once the body was discovered, Britain's requests for the return of the briefcase helped complete the illusion that there was sensitive information contained therein. To further the hoax, Montagu arranged to have Major Martin's name included on the next British casualty list in *The Times*. When the documents were finally returned to the British two weeks later, microscopic examination revealed that the Germans had indeed opened and resealed the letters. Additionally, decrypted German transmissions indicated that the Nazis were moving forces to defend Sardinia, Corsica, and Greece. This news prompted a brief cable to Winston Churchill to inform him of the success: "Mincemeat Swallowed Whole."

On July 9, 1943, Allied forces launched the real Operation Husky and struck the southern tip of Sicily. They swiftly conquered the island, meeting very little resistance given that the bulk of the German forces had been moved away from the area. For the following two weeks the Germans continued to anticipate Husky landings in Sardinia and Greece, but they never came. By the time the Nazis realized that they had been duped, German forces had no chance to regroup effectively, and retreated to Messina. Within a month, the entire island of Sicily was under Allied control.

Montagu's deception was a magnificent success. The action proved highly valuable to the Allies' cause, giving them control of a strategically important location and contributing indirectly to the fall of Mussolini. For his part in the operation, Montagu was awarded with the Military Order of the British Empire. He later wrote a book about the operation, titled *The Man Who Never Was*.

To further the hoax, Montagu arranged to have Major Martin's name included on the next British casualty list in *The Times*.

In the intervening years there has been much investigation and speculation into the true identity of Major William Martin. Due to the findings of amateur historian Roger Morgan in 1996, the "Man Who Never Was" is now believed by many to be Glyndwr Michael, a Welsh vagrant who died after ingesting rat poison and subsequently suffering chemical pneumonia. The markings at his burial place have been updated to show Glyndwr's name on the tombstone; however, not everyone is convinced that he really did play the role of Major Martin. There are some ill-fitting pieces in the Glyndwr theory, such as the length of time between Glyndwr's death and the execution of Operation Mincemeat. Additionally, the HMS *Seraph* took a long detour before heading to the Spanish coast, causing some to suspect that it was retrieving a body from elsewhere, possibly one of the victims of an accident aboard the HMS *Dasher*.

Considering the deliberate efforts to protect the true identity of Major Martin at the time and given the number of years that have passed since his death, it is quite possible that we'll never know his real name with any certainty. Whoever he was, his body did an incalculable service for its country and played a major role in helping to win the war.

THE NAGA FIREBALLS

A fire-breathing river perplexes citizens and scientists

Every year in October near the end of Buddhist Lent, hundreds of people gather after dusk at Wat Paa Luang, a 450-year-old temple on the edge of the Mekong River in the Nong Khai province of Thailand. Though they cannot predict the exact times or locations, a little patience usually earns spectators a view of a small, pinkish sphere rising out of the surface of the river. The glowing ball lingers above the river for up to a few moments, then ascends rapidly and silently into the atmosphere until it is lost to the eye. Most such nights there are dozens to hundreds of the fist-sized wisps flying skyward. Unlike so many other outlandish claims that photography cannot adequately capture, the Naga Fireballs have been witnessed by thousands of people for hundreds of years.

To believers, these fireballs are the breath of the "Naga," a large, magical serpent who patrols the river. Many of the locals tell tales of spotting a silvery flash of scale or speak of an elusive photograph proving the existence of the elusive Naga. Others seek a more rational explanation.

To many, the fireballs appear artificial in their origin, and thus they consider the entire event a hoax. These naysayers, however, offer only anecdotal evidence to support their theory. Supposed hoaxes include tales of the Wat Paa Luang monks secretly planting and lighting fireworks in order to draw crowds, or that the fireballs are simply a tradition of the region's youth celebrating in what amounts to a centuries-long ongoing prank. In any case, 100 years of verified sightings makes the case for a conspiracy a weak one—any such ongoing effort would require preparation, equipment, and a superhuman commitment not to brag to the pretty girls who show up to view the spectacle.

While the phenomenon is most readily observed at night, there are some credible reports of daytime fireballs as well.

Others believe that a natural phenomenon is at play, but look to other causes than the breath of an enormous, camera-shy serpent. While the phenomenon is most readily observed at night, there are some credible reports of daytime fireballs as well, though they are difficult to see in the light. Their appearance is also not isolated to October—they have been spied throughout the year but are especially common in May.

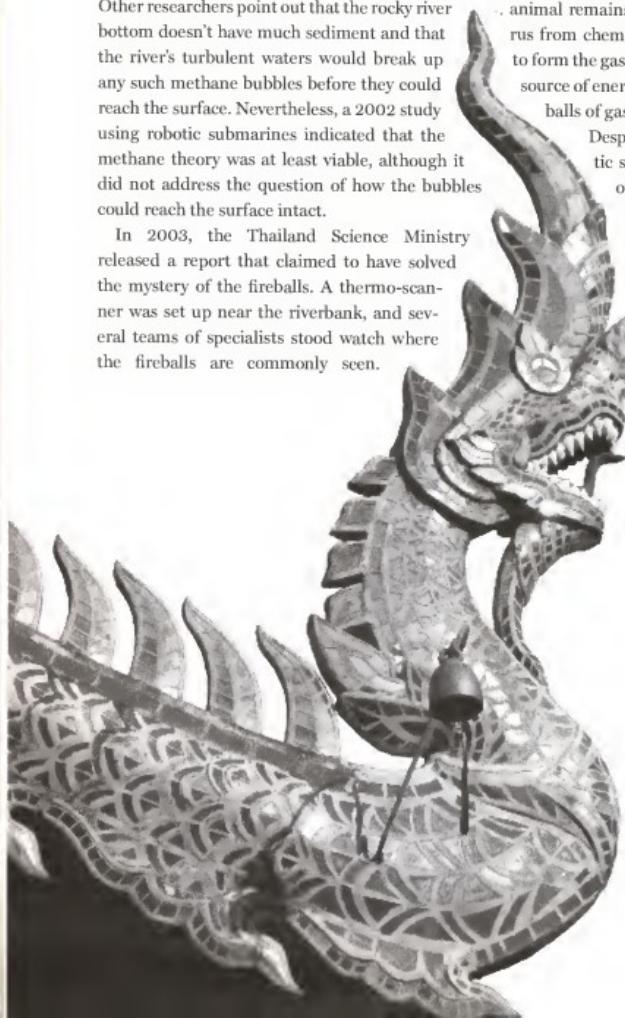
One theory proposed by Manas Kanoksin, a doctor from Nong Khai, postulates that ferment-

ing sediment on the river's bottom causes pockets of methane gas to form. He further suggests that the Earth's position in relation to the sun at those times of year causes the bubbles to rise then spontaneously ignite in the presence of ionized oxygen. Other researchers point out that the rocky river bottom doesn't have much sediment and that the river's turbulent waters would break up any such methane bubbles before they could reach the surface. Nevertheless, a 2002 study using robotic submarines indicated that the methane theory was at least viable, although it did not address the question of how the bubbles could reach the surface intact.

In 2003, the Thailand Science Ministry released a report that claimed to have solved the mystery of the fireballs. A thermo-scanner was set up near the riverbank, and several teams of specialists stood watch where the fireballs are commonly seen.

Reportedly, the scanning equipment detected the movement of phosphine gas coming off the water surface before anyone could see a fireball form. The presence of phosphine seems a reasonable conclusion—as methane released by decay of plant and animal remains could combine with the phosphorus from chemical fertilizer used on nearby farms to form the gas. This does not, however, explain the source of energy or microbes required to make the balls of gas appear fiery.

Despite the locals' preference for romantic silver-serpent stories, the harsh light of science is slowly disassembling the superstitions. Regardless of its natural or supernatural origins, however, this curious and beautiful phenomenon seems to be unique in our world, which lends it a certain awe that no number of sticks-in-the-mud may dislodge.



■ Could the fireballs be the exhalations of a magical serpent that lives in the Mekong River?

NATURE'S NUCLEAR REACTORS

One of mankind's great modern innovations was actually invented by Mother Nature over a billion years ago



uclear reactors represent some of the highest technology that mankind has harnessed for its own purposes. The first, built in the early 1940s, was the culmination of centuries of research into physics, chemistry, and materials science. Collecting enough fissile material to sustain nuclear reactions involved a massive undertaking to locate, extract, and process the ore. Once gathered, the ore required a complex and expensive enrichment process—which was beyond the means of all but a few superrich nations—before it could generate a single watt of power.

But like so many of the pioneering products of man's ingenuity, nature beat us to it—and did it better. A billion and a half years ago, in what is now Gabon in West Africa, a natural nuclear reactor operated for 150 million years without meltdown or explosion. The conditions necessary to produce such a phenomenon no longer exist on this planet, and may have only ever existed in that one location.

In 1972, during a routine analysis of uranium ore deposits, French scientists noticed that ore from the Oklo mines in Gabon was abnormally short in uranium-235 isotopes. The shortfall was significant and required explanation since the discrepancy could be a sign that the ore had been used in weapons production. Upon examination, French scientists found that the uranium isotope levels had an uncanny resemblance to those in spent nuclear fuel from modern nuclear power plants. When no signs of malicious intent could be found, another explanation was sought.

In the early- to mid-1950s, Dr. Paul Kuroda from the University of Arkansas described the possibility of naturally occurring nuclear reactors lurking in the crust of ancient Earth. The key is U-235, which occurs naturally in small amounts. If enough of this isotope were pooled together under specific circumstances, Kuroda theorized, the natural reactor would go critical, and self-sustaining fission would occur. Such a reactor could not exist today, because too much of the Earth's natural U-235 has decayed; but a billion and a half years ago, there was enough of it around to make the idea plausible. Even then, uranium was such a rare ingredient of the Earth's crust that it could not achieve criticality without the help of some concentrating mechanism.

The evidence from Oklo was strong enough to suggest that such a natural reactor might have occurred there, and further exploration confirmed it. The nuclear archaeologists found aluminum foams at the site that were a by-product of the nuclear reactions. By examining the isotopes of xenon gas inside the



■ The water-in-a-hot-crevice process in action.

layers of hardened "bubbles" in these foam deposits, researchers were able to determine the precise reaction and cooldown periods of the reactors.

At the time of discovery, scientists were uncertain how the Oklo reactor had operated without exploding or melting down. For 150 million years, it ran like clockwork with a 30-minute reaction cycle, followed by a 2.5-hour cool-down cycle, producing an average of 100 kilowatts of power per cycle. And the reaction cycle was always *exactly* 30 minutes without significant variation, which baffled early researchers. But recent studies have finally solved the mystery by discovering the mechanism that both regulated and enabled the reactors to occur: ordinary water.

Under normal conditions, radioactive atoms like U-235 cast off neutron particles at speeds so high that most of them skip off the surface of other atoms harmlessly. But if you put enough of the radioactive material together, the cast-off neutrons bounce around inside the material, some slowing down enough to be absorbed into other uranium nuclei. An extra neutron causes the nucleus to become unstable and immediately split, which releases a large amount of energy along with more neutrons. Given enough

density that a lot of nuclei split very rapidly (critical mass), the reaction increases exponentially and results in an atomic explosion. Any less than that (subcritical mass), and a sustained fission reaction can occur, giving off energy as heat and radiation.

Researchers have determined that uranium at Oklo was too spread out to achieve a sustained reaction on its own. Instead, water would seep down through crevices, filling up the gaps between uranium deposits and acting as a "neutron moderator," slowing down the neutrons enough to allow them to hit-and-split other nuclei. This water-enabled reaction generated tremendous heat, eventually causing the water to boil off, thereby removing the neutron moderator and halting the process.

By measuring the volume of water within the reactor and calculating how much energy was released, scientists determined that it took almost exactly 30 minutes to boil the water. Deprived of heat-sustaining reactions, the cavity would then cool over a period of several hours allowing it to slowly refill with water, and the cycle would repeat once again. Though it's not a nuclear reactor, the same water-in-a-hot-crevice process can be seen at Yellowstone National Park. The park's numerous geysers operate on the same basic principle—making the Oklo reactor the "Old Faithful" of the Precambrian era.

Fifteen such natural reactors have since been found in the Oklo area, and they are now collectively referred to as the "Oklo Fossil Reactors." Researchers are using this area to study possible options for the long-term storage of spent nuclear fuel, as well as to garner some insights into possible improvements in man-made reactors. Scientists have also used them to measure how the basic physical properties of the universe—such as the speed of light—might be changing over the eons. The discovery of these unlikely mechanisms deep within the Earth demonstrates that one must never underestimate what is possible given a few basic ingredients and a lot of time. Anything that *can* happen in the universe almost certainly has . . . or will.

NAZI-THWARTING NORWEGIANS

How a small band of saboteurs may have prevented the Nazis from winning the war



In November 19, 1942, a pair of Royal Air Force Halifax bombers shouldered their way through thick winter clouds over Norway with troop-carrying assault gliders in tow. Inside each glider a payload of professional saboteurs from the 1st British Airborne Division weathered a rough ride as the planes approached their intended landing site on frozen lake Møsvatn. Somewhere in the snow-encased hills below, a team of Norwegian commandos vigilantly awaited their arrival.

The ultimate objective of the joint mission was to penetrate and incapacitate the Vemork hydroelectric plant, a fortified Nazi facility nestled high in the mountains of Norway. Though the plant's original purpose had been the production of electricity and fertilizer, the German occupiers were capitalizing on the facility's ability to accumulate large amounts of heavy water—a key ingredient in the Nazi effort to develop an atomic bomb.

Scientists at Vemork stumbled upon heavy water in 1934 when it appeared as a by-product of their ammonia production process. Physically and chemically, the substance is similar to ordinary water, but while the hydrogen atoms in normal H₂O consist of one proton and one electron, many of the hydrogen atoms in heavy water have an extra neutron—resulting in an isotope known as deuterium. This deuterium oxide (D₂O) does exist in water naturally, but its ratio is normally only about one part in 41 million, so it had not been previously observed in significant quantities. For eight years

Vemork's scientists had been collecting the exotic liquid for scientific scrutiny, supplying samples to the world's researchers for experiments. The Nazis' interest, however, was considerably more sinister.

In the late 1930s, a group of German physicists discovered that certain rare isotopes of uranium are fissile, meaning that their nuclei become unstable and split when they absorb an extra neutron. The nucleus shatters into two smaller nuclei as well as some subatomic shrapnel consisting of fast-moving free neutrons. The halves of the split nuclei repel one another with great energy due to their mutually repulsive electric charges. Scientists soon realized that if they collected enough fissionable material together, the free neutrons spawned during one fission would trigger subsequent fissions, which in turn would cause more fissions, and so on. This chain reaction would normally occur rapidly, resulting in explosions and death, but the use of a "neutron moderator" could slow the process into a long-lasting source of heat and neutrons.





■ *The Vemork hydroelectric plant where the Nazis produced "heavy water."*

The Nazis identified Norway's heavy water as one of the best candidates to act as a neutron moderator, so when German forces invaded in 1940, the Vemork plant was an asset they were quick to capture. Under tightened security, the German scientists doubled the heavy water production capacity and began shipping barrels of the material back to weapons laboratories in Berlin. The Norwegian civilian workers knew nothing of nuclear bombs or neutron moderators, but the Nazis' conspicuous interest in the substance prompted members of the resistance to report the activity to British intelligence.

By 1942 the Allied leaders suspected that German physicists intended to use heavy water to create weapons-grade plutonium. The Nazis possessed a stash of rare uranium-235, and in the presence of a moderator such as heavy water, the uranium's free neutrons could be usefully captured. If they were to expose nuggets of the most common uranium element (uranium-238) to such a neutron source, some of the nuclei would slurp up an extra neutron to become uranium-239. U-239 atoms tend to undergo beta decay a couple of times over the course of a few days, ultimately resulting in weapons-grade plutonium-239.

The Allies could not sit idly by as Hitler's henchmen made progress toward fabricating the world's first nuclear weapons. The British Royal Air Force decided that a nighttime bombing raid on

the Vemork was "unrealistic," so a covert ground assault was mounted. On November 19, 30 Royal Engineers crowded into a pair of troop gliders and rode to the frozen landscape of Norway towed behind Halifax bombers.

In the mountains near the power plant, the advance team of Norwegian commandos waited near the landing zone while the planes struggled through the soupy skies. As the drone of aircraft engines crept over the horizon toward Jens Anton Paulsson and his three men, there was a dull explosion in the distance. Once its echoes faded, only one aircraft could be heard. One of the Halifax bombers had struck a cloud-obscured mountain. The glider pilot—who had managed to cast off from his ill-fated tug at the last moment—executed the most graceful crash possible in the mountainous terrain. The remaining airplane and glider circled the area for some time, trying in vain to locate the Norwegians' landing beacon. Eventually low fuel forced them to give up, but as the bomber set off toward home, its tow line broke and sent the second glider and its passengers diving into the snowy hills.

The Germans wasted no time dispatching troops to investigate the commotion. Paulsson and his Norwegian resistance fighters knew they could not reach the distant crash sites ahead of the Germans, so they retreated to their mountain hideaway to await instructions. For three long months the men

subsisted on whatever moss and lichen they were able to scrounge in the subzero temperatures, their diets punctuated by the occasional bit of edible wildlife. Meanwhile the survivors from the crashed gliders were captured, questioned, tortured, and executed under Hitler's top-secret Commando Order, which stipulated that all enemy commandos were to be put to death without exception.

On February 19, 1943, six of the Norwegians' countrymen finally arrived by parachute with a fresh supply of food, weapons, and explosives from their British supporters. Joachim Ronneberg took command of the group and laid out their attack plan. Once everyone had recuperated, the ten men strapped on their skis and set out armed with rifles, submachine guns, chloroform rags, and cyanide suicide pills. They had been given no specific details regarding the power plant's purpose, but the men had been assured that the destruction of certain equipment there would prevent Hitler from gaining the ability to smash entire cities with a single strike.

At three o'clock in the morning on February 28, the gang of intrepid Norwegians approached their target. The Vemork hydroelectric plant was perched on the edge of a 600-foot cliff like a fairy-tale fortress and was accessible via a 240-foot-long bridge that spanned a deep ravine. The area was peppered with mines, and the bridge itself was brightly lit and well-guarded. Given the tactical difficulties of a direct approach, the resistance fighters elected to descend into the gorge and clamber up the cliff on the other side. The force soberly exchanged wishes of good luck then skied down to the ravine floor.

After completing the long and treacherous climb up the icy cliff, Knut Haukelid took command of five of the men and broke off to assume covering positions outside the German barracks. The other four split into two demolition teams, each with a full set of explosives in case one of the teams was unable to reach the target. The four men headed to a basement door that they had been told would be left unlocked, but it refused to budge. The undercover operative in charge of keeping the door unlocked had fallen ill and missed work that day. The two teams separated to seek alternate points of ingress.

Ronneberg and his partner Fredrik Kayser soon located a hatch that allowed access to a narrow maintenance shaft. Despite the tangle of wires and pipes, the men were able to squeeze through. With

the factory's machinery softly grumbling around them, the pair slowly crawled through the long duct, pushing their explosives ahead of them. At the end of the tunnel they quietly climbed down a ladder and surveyed their target: a long row of metallic cylinders lining the wall of the heavy water concentration room. The two raiders sprang into the compartment and caught the lone night watchman completely by surprise. He eagerly complied with their orders to raise his hands, then stood trembling as the armed intruders locked all doors leading into the room.



■ Knut Haukelid led one of the teams responsible for sabotaging the plant.

Ronneberg dashed over to the heavy water tanks and immediately began to set his 18 explosive charges.

As Ronneberg worked, the factory's low, steady hum was punctured by the sound of shattering glass from the far side of the room. He and Kayser spun around with weapons at the ready. Through the window emerged the two men of the other demolition

team, who had resorted to breaking windows after failing to find a more discreet entrance. Together the four men set and checked the series of charges and laid fuses that had been precut to provide a 30-second delay. A Norwegian civilian wandered into the room and was astonished to see a clutch of commandos putting the finishing touches on their demolition charges. He obediently thrust his arms into the air and joined his captive colleague.

Ronneberg lit the bombs' fuses and quietly counted to ten. He then ordered the trembling prisoners to run upstairs as fast as they could. The raiders dropped a British machine gun on the floor to disguise the attack as the work of RAF agents, hoping to prevent reprisals against the local populace. The demolition teams rejoined their comrades outside and dashed away. After several long moments, a muffled thud was heard from the Vemork building behind them. Three thousands pounds of D₂O sloshed out of the damaged tanks and into the factory's drains, destroying four months' worth of production and severely crippling the heavy-water-gathering apparatus. By the time the Germans realized they were under attack, the ten Norwegian men had donned their skis and slipped away to the safety of the mountains.

The saboteurs had successfully silenced the water plant, but the Germans began repairs immediately and within five months their heavy-water collectors were back in action. By the following winter, the Allies had the means to attack the target by air, and during one long day in November 1943, 143 American B-17s pounded the Vemork complex area with more than 700 bombs. Owing to the terrain, many of the bombs missed and most of the structure managed to remain intact, but the forceful series of attacks persuaded the Germans to abandon the plant.

In a last-ditch effort to salvage the remains of the operation, the Nazi scientists loaded their massive bounty of heavy water into a railcar bound for Berlin. When they reached the edge of Lake Timnsjø, the armed procession boarded a ferry. As the boat crossed the deepest portion of the lake there was

a sharp bang below decks. The ferry foundered and sank, dragging the bulk of Germany's atomic bomb program into a deep and watery grave. Knut Haakelid—the Norwegian saboteur who led the raid against Vemork—had learned of the plans to move the cargo and smuggled a makeshift time bomb aboard the ferry before the Germans arrived. Unfortunately 14 civilians were killed but resistance leaders reasoned that these losses were acceptable considering the thousands of lives that would have been forfeit if Hitler's nuclear program had come to fruition.

By the time the Germans realized they were under attack, the ten Norwegian men had donned their skis and slipped away to the safety of the mountains.

Though the Norwegians' handiwork did not completely halt the progress of the Nazi's atomic bomb project, it created significant stumbling blocks. According to some controversial reports, the Nazis managed to build and test a small nuclear device just before the war ended, but it was reportedly a crude design far inferior to the bombs dropped on Japan some months later by the U.S. In any case, the Nazis certainly possessed the knowledge and skills necessary to construct a bomb, but with the help of the Norwegian saboteurs, they were denied the resources.

By some estimations, the raids at Vemork were all that prevented Hitler from gaining control over Europe and ruling with a plutonium fist. Indeed, had the Nazis worked unhindered, the world's first atomic mushroom cloud may have loomed over London by the mid-1940s. In that respect, these stalwart saboteurs and their daring mission in the mountains of Norway may have spared the world from a far worse fate.



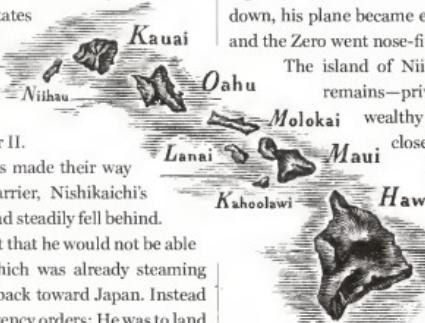
THE NIIHAU ISLAND INCIDENT

How one traitorous couple helped launch the Japanese Internment of World War II

When the Empire of Nippon launched its massive attack on Pearl Harbor on the morning of December 7, 1941, Airman 1st Class Shigenori Nishikaichi was among the raiders, escorting a group of bombers in his Zero fighter. After two successful runs, the bombers were seeking further targets when, seemingly from nowhere, a flight of nine U.S. air fighters attacked them. The U.S. forces were flying P-36As, and were hugely outclassed by the Zeros. Despite the advantage of surprise, the U.S. planes were quickly eliminated.

Nevertheless, the U.S. airmen did strike some targets, including puncturing the fuel tank of Shigenori Nishikaichi's fighter. That single bullet set into motion events that would eventually lead to the United States interning more than 100,000 of its own citizens in concentration camps for the remainder of World War II.

As the Japanese pilots made their way back to the aircraft carrier, Nishikaichi's injured plane lost fuel and steadily fell behind. It soon became apparent that he would not be able to reach the carrier, which was already steaming away from Hawaii and back toward Japan. Instead he fell back on his emergency orders: He was to land on the uninhabited island of Niihau and wait on the north beach for an Imperial submarine to make rescue. On his first flyby, however, he noticed a serious flaw in the plan: Contrary to Japan's preattack intelligence, the tiny island was not uninhabited.



Choice of landing locations was sparse. On his second pass over Niihau, Nishikaichi located an area that appeared suitable and attempted a landing near an isolated house. As he began to touch down, his plane became entangled in a wire fence, and the Zero went nose-first into the ground.

The island of Niihau was then—and still remains—privately owned by the wealthy Robinson family. It was closed to outsiders, but native Niihauans and members of the Robinsons did live on the island, raising cattle and sheep and harvesting honey. One of the island residents, a Hawaiian named Howard Kaleohano,

■ Much to Airman Nishikaichi's dismay the island of Niihau was inhabited.

watched the plane crash and—unaware of the nearby attack on the neighboring island—rushed out to help. The pilot emerged rather beaten and groggy. Kaleohano took the pilot's papers and side-arm before he hefted the man away from the wreck. Kaleohano was one of the few island residents who spoke English, but Nishikaichi's English was very rudimentary. A neighbor who was born in Japan was summoned to help. But after trading only a few words with the pilot, the translator's face was cast in a pallor—as though he'd received a terrible shock—and he refused to have any further part in the strange events.

The pilot pulled his pistol from his boot and shot Ben Kanahele thrice—chest, hip, and groin—but it wasn't enough to stop the enraged Hawaiian.

The baffled Kaleohano next called in Yoshio Harada, a second-generation Japanese immigrant born in the Hawaiian Islands. Harada and his wife Irene were the only other inhabitants of the island who spoke both Japanese and English. After some interrogation, the downed pilot told the couple about the attack on Oahu and demanded the return of his weapon and papers. His demands were refused—but for reasons unknown, the Haradas decided not to share the news of the newly started war with the other islanders.

With neither telephones nor electricity on Niihau to alert them, the oblivious islanders spent the day treating their guest to a luau. Nishikaichi ate well and even sang for his hosts, unaware that his rescue sub had already been ordered to head back into the Pacific to intercept any incoming U.S. ships.

By nightfall, however, a battery-operated radio informed the residents of Niihau about the day's

tragic events. Nishikaichi was taken into custody. The next day, Yoshio Harada escorted the captured pilot to Kii Landing to await the authorities.

Unbeknownst to them, the Navy had curtailed maritime traffic, preventing the transport from reaching Niihau to pick up the prisoner. Nishikaichi used this delay to tamper with his captor's loyalties, pitting Harada's citizenship against his heritage. Finally on Friday, December 12, Harada's allegiance swayed. That afternoon, the Japanese-American Harada stole a pistol and a shotgun, and staged an escape with Nishikaichi. The two men returned to the house where the Zero had crashed, but didn't find the owner there—Kaleohano had seen them approaching and hid in the outhouse. The two fugitives unsuccessfully tried to use the plane's radio, then turned back for the nearby house. As they returned, Kaleohano sprang from his hiding place and dashed away to make his escape. Nishikaichi fired at the fleeing Hawaiian, but missed.

Battle lines were drawn: the three Japanese on one side, and a growing band of Niihauans on the other. Around midnight, Kaleohano and five others set out in a lifeboat across the black Atlantic in search of help on Kauai—ten hours away. Other islanders lit a signal fire atop Niihau's highest point, Mount Paniau, which was visible from Kauai. Due to the obvious desperation in the signals, the transport ship was finally allowed to depart for Niihau.

Meanwhile, the Japanese conspirators stormed the town and captured a small group of residents. The renegade pilot demanded that Kaleohano be turned over to him. Though the islanders knew that the man had set off for Kauai, they stalled by engaging in a false search. When the moment presented itself, one captive islander—a burly sheepherder by the name of Ben Kanahele—made his move. In Hawaiian, Kanahele told Harada to ask his Japanese cohort for a weapon. Harada did so, and as the shotgun was changing hands, Kanahele and his wife Ella rushed Nishikaichi.

The pilot pulled his pistol from his boot and shot Ben Kanahele thrice—chest, hip, and groin—but it wasn't enough to stop the enraged Hawaiian. He lifted the Japanese pilot and dashed him against a stone wall. Kanahele's wife took up a rock and began to cave in the pilot's skull until her husband got a knife and finished the man off. As his comrade in treachery fell, Yoshio Harada turned the shotgun into his own gut and fired. The "Battle of Niihau" was over.

Ben Kanahele recovered from his wounds. In August 1945 he was awarded two presidential citations, the Medal of Merit and the Purple Heart.

Consequences of the events on Niihau proved sweeping. The incident spawned a Navy report that indicated a "likelihood that Japanese residents previously believed loyal to the United States may aid Japan." Irene Harada was imprisoned for her part in helping the pilot escape. President Franklin D. Roosevelt used the incident and subsequent naval report to help rationalize Executive Order 9066, which allowed local military commanders to designate "military areas" as "exclusion zones" from which "any or all



■ Irene and Yoshio Harada's aid to Nishikaichi led to the forced internment of over 120,000 Japanese-Americans at "relocation centers" such as this one.

persons may be excluded." It would be less than two weeks before the order was interpreted to allow the segregating of all people of Japanese descent from the West Coast into concentration camps in the interior U.S. The actions of one man in a unique situation ultimately led the U.S. government to imprison more than 120,000 innocent Americans, all in a misguided measure intended to protect the country from future betrayals.

THE NUCLEON

Ford Motor Company's vision for an atomic-age wonder-car

During the 1950s, much of the world was quivering with anticipation over the exciting prospects of nuclear power. Atomic energy promised to churn out clean, safe electricity that would be "too cheap to meter." It seemed that there was no energy problem too large or too small for the mighty atom to tackle during the glorious and modern atomic age.

It was during this honeymoon with nuclear energy—in 1957—that the Ford Motor Company unveiled the most ambitious project in its history: a vehicle design that had a sleek futuristic look, emitted no harmful vapors, and offered incredible fuel mileage far beyond that of the most efficient cars ever built. This automobile-of-the-future was called the Ford Nucleon, named for its highly unique design feature: an ultra-compact atomic fission reactor in the trunk.

Designers anticipated that a typical Nucleon would travel about 5,000 miles per charge.

Ford imagined a world in which full-service recharging stations would one day supplant petroleum fuel stations and where a depleted reactor could be swapped out for a fresh one lickety-split. The company's automotive engineers intended to use a reactor modeled after those found in nuclear submarines, but miniaturized for automobile use. It would use uranium fission to heat a steam generator, rapidly converting stored water into high-pressure steam that could then be used to drive a

set of turbines. One steam turbine would provide the torque to propel the car while another would drive an electrical generator. Steam would then be condensed into water in a cooling loop, and sent back to the steam generator to be reused. Such a closed system would allow the reactor to produce power as long as fissile material remained.

Using this system, designers anticipated that a typical Nucleon would travel about 5,000 miles per charge. Because the power plant was an interchangeable component, owners would have the freedom to select a reactor configuration based on their personal needs, ranging anywhere from a souped-up uranium guzzler to a low-torque, high-mileage version. And without the noisy internal combustion and exhaust of conventional cars, the Nucleon would be relatively quiet, emitting little more than a turbine whine.

The vehicle's aerodynamic styling, one-piece windshield, and dual tail fins (which are absent in some photographs) are reminiscent of spacecraft from 1950s-era science fiction, but some aspects of the Nucleon's unique design were more utilitarian. For instance, its passenger area was situated quite close to the front of the chassis, extending beyond the front axle. This arrangement was meant to distance the passengers from the atomic power plant in the rear and to provide maximum axle support

to the heavy equipment and its attendant shielding. Another practical design aspect was the addition of air intakes at the leading edge of the roof and at the base of the roof supports, apparently to be used as part of the reactor's cooling system.

Perhaps more than any other atomic-era aspirations, Ford's nuclear automobile embodied the naive optimism of the era. Most people were ignorant of the dangers of the atomic contraption and of the risk that every minor fender-bender could have the potential to become a radioactive disaster. In fact, the public greeted the Nucleon concept with great enthusiasm. Some sources even claim that the U.S. government sponsored Ford's atomic car research program.

The Nucleon's silent, sleek, and efficient design seemed poised to secure its place in the American lifestyle of the future. It appeared inevitable that the

tacticality; the bulky apparatus and heavy lead shielding didn't allow for a safe and efficient car-sized package. Moreover, as the general public became increasingly aware of the dangers of atomic energy and the problem of nuclear waste, the thought of radioactive "automobiles" zipping around town lost much of its appeal. Atoms had broken their promise. The honeymoon was over.

Ford never actually produced a fission-powered prototype, but nevertheless the sleek Nucleon remains an icon of the atomic age. In spite of the Nucleon's flaws, its designers deserve a



nod for
their slap-
dash ingenuity.

Their reckless confi-
dence demonstrates that
one shouldn't consider a task
impossible just because nobody

has tried it yet—some ideas need to be debunked on their own merit. With today's looming energy crisis and slow migration to alternative fuel sources, we may not have seen the last of this automobile concept. A safe atomic vehicle may not be beyond our reach, as the U.S. Navy has demonstrated with its (so far) perfect record of nuclear safety. Perhaps one day fossil fuels will wither under the radioactive glare of the mighty atom and our highways will hum with the steam turbines of mobile Chernobyls. It could be a real blast.

internal combustion engine would fade into obscurity, becoming a quaint relic of a pre-atomic past. But the Nucleon's design hinged on the assumption that sufficiently small nuclear reactors would be developed, as well as lighter shielding materials. When those innovations failed to appear, the project was scrapped due to conspicuous imprac-

■ You can see a prototype of the Nucleon at the Henry Ford Museum in Dearborn, Michigan.

THE FLYING NUCLEAR FORTRESS

During the 1940s, the U.S. Air Force started a program to transform the Convair B-36 bomber design into a nuclear-powered behemoth that would be called the X-6. The advantages of an atomic airplane were clear: An onboard reactor could provide unlimited range and weeks-long endurance for an intercontinental transport aircraft or bomber.

The engineers embarked on the project in a spirit of unmitigated optimism, and the military appeal of a nuclear aircraft initially ensured a ready supply of funds. A Convair was duly converted and designated the NTA (nuclear test aircraft). It flew with an operating nuclear reactor in its bomb bay on 47 occasions between 1955 and 1957. The reactor on the NTA never provided thrust for the aircraft, but the test bed allowed researchers to explore some of the radiation shielding issues inherent in the proposed design. The plane was extensively fitted with lead, rubber, and water-pocket shielding to protect the crew compartment, but other shielding was left out due to weight concerns, and radiation freely escaped above, below, and to the sides of the reactor.

On the ground, the General Electric company began work on a nuclear engine for the aircraft. It was an ingenious blend of nuclear reactor and turbojet. A standard jet engine produced thrust from heated, compressed exhaust gases generated from fuel burned in a combustion chamber, but the nuclear engine supplied heated, compressed gas by passing air through an experimental lightweight reactor. Three nonflying prototypes of this "direct cycle" design were eventually built, with the last, called HTRE-3, achieving performance theoretically sufficient for an X-6 to fly for 30,000 miles at 460 mph without refueling. However, the size of the assembly remained too large for mounting in an aircraft, and safety concerns dogged the project; with the exhaust gas having direct contact with the reactor core, the air inlets and outlets were identified early on as possible sites of radiation leakage.

Broader concerns were also voiced about the issue of nuclear reactors flying at high speeds and altitudes, entering combat zones, or generally operating in the vicinity of people. Yet it seems it was financing that ultimately sealed the program's fate. Although there were no insurmountable technical problems in the X-6 proposal, by 1961 an atom-powered airplane was still a long way from flying, and more than \$7 billion had been thrown at the project. Perhaps unsurprisingly it was canceled by the incoming Kennedy administration, and the Convair X-6 joined the Ford Nucleon in the nuclear-powered dustbin.



■ A B-36 bomber being assembled.

ONODA'S LONG WAR

Failing to get the message that World War II has ended, a group of Japanese army guerillas carry their orders out to the extreme

On the small island of Lubang in the Philippines, local villagers tell stories of phantomlike soldiers who lingered in the jungle for decades after the end of World War II. These guerrilla ghosts would go unseen for years on end, but they made their presence known by slaughtering cows in the fields, burning harvested rice, and shouting angry warnings in Japanese from the hills. Occasionally the sound of rifle fire would echo through the valleys, sometimes leaving villagers wounded or dead. Such improbable reports continued well into the 1970s, but unlike most such stories, the phantom soldiers of Lubang were quite real.

On December 17, 1944, a 23-year-old Japanese soldier named Hiroo Onoda arrived on the island of Lubang to join the Sugi Brigade, a unit charged with defending several Pacific islands from the advancing American invaders. Onoda was ordered to lead the garrison in guerrilla warfare. "The first thing for you to do is destroy the Lubang air field and the pier at the harbor," his commanding officer Major Takahashi explained. "Should the enemy land and try to use the airfield, destroy their planes and kill the crews."

Before departing from Japan, Onoda's division commander left him with these words: "You

are absolutely forbidden to die by your own hand. It may take three years, it may take five, but whatever happens, we'll come back for you. Until then, so long as you have one soldier, you are to continue to lead him. You may have to live on coconuts. If that's the case, live on coconuts! Under no circumstances

are you to give up your life voluntarily." A true soldier, Onoda took the order to heart. It would be 29 years before he surrendered.

In February 1945, just two months after Onoda's arrival on Lubang, the Allied forces attacked the island and quickly overtook its defenses. As the Allies moved inland, Onoda and the other guerrilla soldiers split into groups and retreated into the dense jungle. Onoda's group consisted of himself and three other men: Corporal Shimada, Private Kozuka, and Private Akatsu. They survived for several months by rationing their rice supply, eating coconuts

and green bananas from the jungle, and occasionally killing one of the locals' cows for meat.

While on one such a cow-killing errand, one of the soldiers found a note. It was a leaflet left behind by a local resident that read, "The war ended on August 15. Come down from the mountains!" The

A true soldier, Onoda took the order to heart. It would be 29 years before he surrendered.

men scrutinized the note and decided that it was an Allied propaganda trick to coax them out of hiding.

Onoda and his men lived in the jungle for years, occasionally engaging in skirmishes and carrying out acts of sabotage to fulfill their guerrilla mission. They were tormented by jungle heat, incessant rain, rats, and insects. When the Japanese guerrillas spotted a villager, they attacked the "spy" in full force, wounding and killing many people over a few years. Armed search parties were sent to rout out the rogue soldiers, but Onoda and his men were able to slip away and hide on each occasion. In the meantime, fliers, newspapers, and letters from relatives back in Japan were dropped from planes or left in the jungle, urging the soldiers to give themselves up. Each attempt was assumed to be a clever hoax by the Allies.

In September 1949, after four years of hiding, one of Onoda's fellow soldiers decided he'd had enough. Without a word to the others, Private Akatsu snuck away one morning, and the Sugi Brigade was reduced to three men. Sometime the next year they found a note from Akatsu informing them that he had been greeted by friendly troops when he left the jungle and that the war had ended almost five years earlier. To the remaining men, it was clear that Akatsu was being coerced into working for the enemy and was not to be trusted. They continued their guerrilla attacks, but with more caution. They continued to encounter local villagers on occasion, but a fierce shout in Japanese was usually enough to frighten them away.

Four years later, in 1953, Corporal Shimada was wounded in the leg during a shootout with some fishermen. Onoda and Kozuka helped him back into the jungle, and without any medical supplies, managed to nurse him back to health over several months. About a year later, however, the 40-year-old soldier was fatally wounded during a skirmish with a search party. All that was left of the Sugi Brigade was two tenacious men.

For the next 19 years Onoda and Kozuka continued their guerrilla activities together, living in the

dense jungle in makeshift shelters. The villagers tended to forget about their armed neighbors in the hills, but every now and then Onoda and Kozuka would kill a cow for meat, prompting the army to embark on yet another fruitless search for the men. The two remaining soldiers operated under the conviction that the Japanese army would eventually retake the island from the Allies, and that their guerrilla tactics would prove invaluable in that effort. Their perseverance would make them heroes.

In October 1972, their 27th year of hiding, Onoda and Kozuka snuck out of the jungle to burn some rice collected by local farmers in an attempt to sabotage the "enemy's" food supply. A Filipino police patrol spotted the men and fired two shots, killing 51-year-old Kozuka. Onoda escaped back into the jungle, now alone in his misguided mission.



■ Hiroo Onoda prepares to leave the island of Lubang after 29 years of hiding.

News of Kozuka's death traveled quickly to Japan. It was concluded that since Kozuka had survived all those years, it was likely that Onoda still lived as well, though he had been declared legally dead about 13 years earlier. More search parties were sent in to find him, but Onoda successfully evaded them each time.

In the early evening of February 20, 1974, a year and a half after Kozuka's death, Onoda was creeping through a *nanka* grove when he spotted something out of the ordinary. A small tent of mosquito netting had been erected along the riverbank, and a man was nearby building a small fire. Onoda released the safety lock on his rifle. After looking around the camp for weapons and finding none, he shouted at the man in an attempt to frighten him away. The man stood quickly, but he did not flee. Instead, he turned, and raised a trembling hand to his forehead in a military salute. The stranger, clad in blue jeans, a T-shirt, and rubber sandals, shouted in a high-pitched voice, "I'm Japanese! I'm Japanese!"

The man was Norio Suzuki, a college dropout from Japan who had left on a globe-hopping vacation to seek out some of the world's most elusive figures: a wild panda, the abominable snowman, and Lieutenant Onoda. Suzuki explained that the war had ended long ago, and asked Onoda to return to Japan with him. Onoda replied, "No, I won't go back! For me, the war hasn't ended!"

"What do you plan to do? Die here?" Suzuki asked. "I will if I don't have any orders to the contrary."

Suzuki offered the 52-year-old soldier a cigarette, a Japanese novel, and some pornography. Onoda accepted the cigarette. Suzuki then took photos of the two of them together, and told Onoda that he would return in two weeks.

Two weeks later, Onoda checked a box that Suzuki had designated as a message drop-off point. Inside was a note reading, "I've come back for you, just as I promised," along with orders from the Japanese Army to cease all guerrilla activities and go to Wakayama Point for further instructions. There were also a pair of photos showing two men in the jungle. One of the men was Norio Suzuki, and the other was a weathered old man in a tattered

Japanese army uniform—Second Lieutenant Hiroo Onoda.

Still wary that all of this might be an elaborate ruse by the enemy, Onoda proceeded to the meeting with caution. Nevertheless, he arrived in what was left of his dress uniform, wearing his sword and carrying his still-working Arisaka rifle, 500 rounds of ammunition, and several hand grenades. His former commanding officer Major Taniguchi, having become a bookseller and long since retired from the military, met him there. He read aloud the orders: Japan had lost the war, and all combat activity was to cease immediately. After a moment of quiet anger, Onoda pulled back the bolt on his rifle and unloaded the bullets, then removed his pack and laid the weapon across it. When the reality of it sunk in, he wept openly.



■ Onoda returned to Japan to a hero's welcome.

SWAMP THINGS

In the same month that the Allied forces pressed Hiroo Onoda into a hiding, a thousand-strong unit of retreating Japanese soldiers entered a mangrove swamp around the Burmese island of Ramree. With the area totally surrounded, the attacking British forces elected not to pursue the enemy into the treacherous terrain. Calls to surrender were broadcast from land and sea, and the victorious Allies settled down to wait.

That night, sailors on the British patrol boats detected some disturbing sounds emanating from the depths of the swamp. Scattered rifle shots punctuated the evening, together with the sounds of splashing and screams. British troops were not actively engaging the Japanese, so the source of the shocking noise had to be something else. Soon the sailors realized that the enemy of their enemy was their friend: The local, infamous saltwater crocodiles must have decided to feed on the trespassers.

The exact number of people devoured that night is disputed. Estimates suggest that up to 500 soldiers escaped the hellish swamp and rejoined the remnant of a larger Japanese unit on the mainland, and others no doubt died from exhaustion, battle wounds, and confused gunfire. Even so, the Ramree massacre is noted in the Guinness Book of World Records as the worst recorded incident of human predation by crocodiles. Several hundred souls are thought to have perished in the jaws of these aggressively territorial reptiles.



By the time he formally surrendered to Philippine President Ferdinand Marcos in 1974, Onoda had spent 29 of his 52 years hiding in the jungle, fighting a war that had long been over for the rest of the world. He and his guerrilla soldiers had killed some 30 people during those years and wounded about a hundred others. But they had done so under the belief that they were at war, and consequently President Marcos granted Onoda a full pardon for the crimes he had committed while in hiding.

Hiroo Onoda returned to Japan to a hero's welcome and 29 years of back pay from the military, but neither helped him adjust to his new modern life. Eventually he published *No Surrender: My Thirty-Year War*, a memoir of his time on the island. Some years later Onoda married a Japanese woman, and established a nature camp for kids where he shared what he had learned about survival through resourcefulness and ingenuity. As of early 2009, Onoda is alive in Japan. It is unknown whether he still suspects an elaborate ruse.

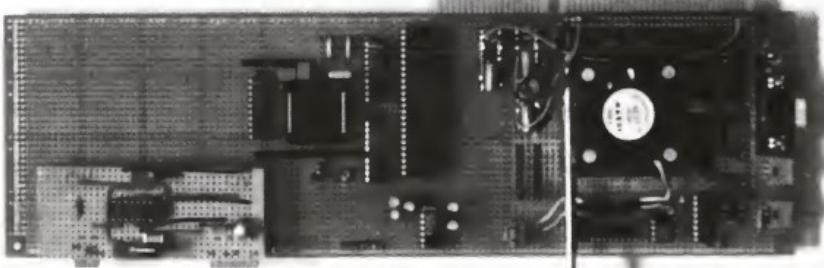
ON THE ORIGIN OF CIRCUITS

When principles of evolution are applied to computer chips, fascinating technological advances ensue

In a unique laboratory in Sussex, England, a computer carefully scrutinized every member of a large and diverse set of candidates. Each was evaluated dispassionately and assigned a numeric score according to a strict set of criteria. This machine's task was to single out the best possible pairings from the group, then force the selected couples to mate so that it might extract the resulting offspring and repeat the process with the following generation. As predicted, with each breeding cycle the offspring evolved slightly, nudging the population incrementally closer to the computer's preprogrammed definition of the perfect individual.

The candidates in question were not the stuff of blood, guts, and chromosomes that are normally associated with evolution, rather they were clumps of ones and zeros residing within a specialized computer chip. As these primitive bodies of data bumped together in their silicon logic cells, Dr. Adrian Thompson—the machine's master—observed with curiosity and enthusiasm.

Thompson is a researcher at the Department of Informatics at the University of Sussex. In the mid-1990s his experiments were some of the first practical attempts at penetrating the virgin domain of hardware evolution. The concept is roughly analogous to Charles Darwin's elegant principle of natural selection, which describes how individuals with



■ One of Dr. Adrian Thompson's first circuit boards.

the most advantageous traits are more likely to survive and reproduce. This process tends to preserve favorable characteristics by passing them to the survivors' descendants, while simultaneously suppressing the spread of less-useful traits.

Thompson dabbled with computer circuits in order to determine whether survival-of-the-fittest principles might provide hints for improved microchip designs. As a test bed, he procured a special type of chip called a Field-Programmable Gate Array (FPGA) whose internal logic can be completely rewritten—unlike normal chips, which have a fixed design. This flexibility results in a circuit whose operation is hot and slow compared to conventional counterparts, but it allows a single chip to become a modem, a voice-recognition unit, an audio processor, or just about any other computer component. All one must do is load the appropriate configuration.

The informatics researcher began his experiment by selecting a straightforward task for the chip to complete: He decided that it must reliably differentiate between two particular audio tones. A traditional sound processor with its hundreds of thousands of preprogrammed logic blocks would have no trouble filling such a request, but Thompson wanted to ensure that his hardware evolved a novel solution. To that end, he employed a chip only ten cells wide and ten cells across—a mere 100 logic gates. He also strayed from convention by omitting the system clock, thereby stripping the chip of its ability to synchronize its digital resources in the traditional way.

He cooked up a batch of primordial data soup by generating 50 random blobs of ones and zeros. One by one his computer loaded these digital genomes into the FPGA chip, played the two distinct audio tones, and rated each genome's fitness according to how closely its output satisfied preset criteria. Unsurprisingly, none of the initial randomized configuration programs came anywhere close. Even the top performers were so profoundly inadequate that the computer had to choose its favorites based on

tiny nuances. The genetic algorithm eliminated the worst of the bunch, and the best were allowed to mingle their virtual DNA by swapping fragments of source code with their partners. Occasional mutations were introduced into the fruit of their digital loins when the control program randomly changed a one or a zero here and there.

For the first hundred generations or so, there were few indications that the circuit-spawn were any improvement over their random-blob ancestors. But soon the chip began to show some encouraging twitches. By generation No. 220, the FPGA was essentially mimicking the input it received, a reaction that was a far cry from the desired result, but evidence of progress nonetheless. The chip's performance improved in minuscule increments as the nonstop electronic orgy produced a parade of increasingly competent offspring. Around generation No. 650, the chip had developed some sensitivity to the 1 kHz waveform, and by generation No. 1,400, its success rate in identifying either tone had increased to more than 50 percent.

Researchers speculate that robots might one day use evolution-inspired systems to quickly adapt to unforeseen obstacles in their environment.

Finally, after just over 4,000 generations, the test system settled upon the best program. When Thompson played the 1 kHz tone, the microchip unfailingly reacted by decreasing its power output to zero volts. When he played the 10 kHz tone, the output jumped up to five volts. He pushed the chip even farther by requiring it to react to vocal "stop" and "go" commands, a task it met with a few hundred more generations of evolution. As predicted, the principle of natural selection could successfully produce specialized circuits using a fraction of the

resources a human would have required. And no one had the foggiest notion how it worked.

Thompson peered inside his perfect offspring to gain insight into its methods, but what he found inside was baffling. The plucky chip was utilizing only 37 of its 100 logic gates, and most of them were arranged in a curious collection of feedback loops. Five individual logic cells were functionally disconnected from the rest—with no pathways that would allow them to influence the output—yet when the researcher disabled any one of them, the chip lost its ability to discriminate the tones. Furthermore, the final program did not work reliably when it was loaded onto other FPGAs of the same type.

It seems that evolution had not merely selected the best code for the task, it had also advocated those programs that took advantage of the electromagnetic quirks of that specific microchip. The five separate logic cells were clearly crucial to the chip's operation, but they were interacting with the main circuitry through some unorthodox method—most likely via the subtle magnetic fields that are created when electrons flow through circuitry, an effect known as magnetic flux. There was also evidence that the circuit was not relying solely on the transistors' absolute ON and OFF positions like a typical chip; it was capitalizing upon analogue shades of gray along with the digital black and white.

Today, researchers are just beginning to explore the real-world potential of evolving circuitry. Engineers are experimenting with rudimentary

adaptive hardware systems that marry evolvable chips to conventional equipment. Such hybrids quickly adapt to new demands by constantly adjusting their own control code. The space exploration industry is intrigued by the technology—an evolving system could dynamically reprogram itself to avoid any circuits damaged by radiation, reducing the need for heavy shielding and redundant systems. Similarly, researchers speculate that robots might one day use evolution-inspired systems to quickly adapt to unforeseen obstacles in their environment.

Modern supercomputers are also contributing to artificial evolution, applying their massive processing power to develop simulated prototypes.

The initial designs are thoroughly tested within carefully crafted virtual environments, and the best candidates

are used to breed successive batches until a satisfactory solution has evolved. These last-generation designs are then fabricated and tested in the real world. NASA recently used this approach to produce the antenna for a space-going vessel, resulting in flamboyant yet effective shapes that vaguely resemble organic life-forms unlike anything an engineer would design without the benefit of psychedelic drugs. Scientists hope to eventually use genetic algorithms to improve complex devices such as motors and rockets, but progress is dependent upon the development of extremely accurate simulations.

These evolutionary computer systems may almost appear to demonstrate a kind of sentience as they dispense graceful solutions to complex problems. But this apparent intelligence is an illusion caused by the fact that the overwhelming majority of design variations tested by the system—most



■ Dr. Adrian Thompson is a pioneer in the field known as "evolvable hardware" or "evolutionary electronics."

of them appallingly unfit for the task—are never revealed. According to current understanding, even the most advanced microchips fall far short of the resources necessary to host legitimate intelligence. On the other hand, at one time many engineers might have insisted that it's impossible to train an unclocked 10×10 FPGA to distinguish between two distinct audio tones.

Poorly defined criteria might allow a self-adapting system to explore dangerous options in its single-minded thrust toward efficiency, placing human lives in peril.

There is also an ethical conundrum regarding the notion that human lives may one day depend upon these incomprehensible systems. There is concern

that a dormant “gene” in a medical system or flight control program might express itself without warning, sending the mutant software on an unpredictable rampage. Similarly, poorly defined criteria might allow a self-adapting system to explore dangerous options in its single-minded thrust toward efficiency, placing human lives in peril. Only time and testing will determine whether these risks can be mitigated.

If evolvable hardware passes muster, the Sussex circuits may pave the way for a new kind of computing. Given a sufficiently well-endowed Field-Programmable Gate Array and several thousand exchanges of genetic material, there are few computational roles that these young and flexible microchips will be unable to satisfy. While today's computers politely use programmed instructions to solve predictable problems, these adaptable alternatives may one day strip away such limits and lay bare the elegant solutions that the human mind is reluctant—or powerless—to conceive on its own.

OPERATION PASTORIUS

The Nazi's ill-fated attempt to infiltrate the U.S. mainland

Just after midnight on the morning of June 13, 1942, 21-year-old coastguardsman John Cullen was beginning his foot patrol along the coast of Long Island, New York. Although this particular stretch of beach was considered a likely target for enemy landing parties, the young seaman was the sole line of defense on that foggy night, and his only weapon, a trusty flashlight, was proving ineffective against the smothering haze. As Cullen approached a dune, the shape of a man suddenly appeared before him. Momentarily startled, he called out for the figure to identify itself.

"We're fishermen from Southampton," a voice responded. A middle-aged man emerged from the soupy fog and continued, "We've run ashore." This sounded plausible to Cullen, so he invited the fisherman and his crew to stay the night at the nearby Coast Guard station. The offer appeared to agitate the man, and he refused. "We don't have a fishing license," he explained.

Cullen's suspicions were beginning to grow when a second figure appeared over the dune and shouted something in German. The man in front of Cullen spun around, yelling, "You damn fool! Go back to the others!" Then he turned back to Cullen with an intensity in his expression that left the seaman paralyzed—for it was now almost certain that he was alone on the beach with a party of Nazi spies.

The German agent stood close, and hissed, "Do you have a mother? A father?" As Cullen nodded, he went on, "Well, I wouldn't want to have to kill you." He held out a wad of cash. "Forget about this, take this money, and go have a good time." Cullen, realizing this might be his only chance to walk away alive, decided to accept. As he reached for the roll of bills, the man suddenly lunged forward and seized

Cullen's flashlight. He pointed it toward his own face. "Do you know me?" he asked.

"No sir, I never saw you before in my life."

"Take a good look at me. You'll be meeting me in East Hampton sometime." With that, he released his grip on the flashlight and the money, and disappeared back into the fog. The shocked coastguardsman took a few hesitant paces backward, then whirled around and set off at a run for the Coast Guard station to inform his superiors that their fears had been realized.

Cullen's suspicion was correct, but what he didn't know was that the man he'd confronted was no hardened military commander. He was George John Dasch, a waiter and dishwasher who'd come to the attention of the German High Command for the time he'd spent living in America before the war. He and a team of three similarly inexperienced agents had been given several weeks of intense training at a secret farm near Berlin before being ushered onto a U-boat bound for the U.S. coast. Their mission, led by Dasch, was to sabotage America's manufacturing and transport sector and to terrorize the country's civilian population. It would be known as *Operation Pastorius*.

John Cullen reached the Coast Guard post and breathlessly recited what he'd seen, handing over the bribe money as evidence. Though skeptical, and concerned about raising a false alarm, his superiors agreed to send out an armed patrol to investigate. They were led back to the site by Cullen, where any doubts were quickly dispelled; in the predawn light, the men could see the outline of a German submarine dislodging itself from a sandbar just offshore. Once it had gone, a quick search of the area revealed a series of small crates buried under a shallow layer of sand. Inside were large quantities of explosives, detonation equipment, Nazi uniforms, and quality German liquor.

Once the news reached FBI director J. Edgar Hoover around noon, his excitement could hardly be contained. As Attorney General Francis Biddle later recalled, "All of Edgar Hoover's imaginative and restless energy was stirred into prompt and effective action. He was determined to catch them all before any sabotage took place." Here at last was a chance for Hoover to prove his organization's value to the war effort. But the situation was delicate; making the story public would put every American citizen on the lookout for the Germans, but it would also alert the suspects

to the hunt and might cause public hysteria—not to mention considerable embarrassment for Hoover and his Bureau if the search should fail. It was therefore decided that a media blackout be imposed. Quietly, with only the most professional degree of panic, the FBI began the largest manhunt in its history.

By this time, the four would-be terrorists were settled in New York City, preparing for their task from the comfort of fancy hotels and fine restaurants. They had a little more than \$84,000 in mis-

sion funds to enjoy—equivalent to over \$1 million today—and in the great melting pot of New York City, their German accents raised nary an eyebrow.

But George John Dasch, the group's daring leader, had a secret. The day after the landing, he called Ernst Peter Burger, the most guarded and disciplined member of the team, into the upper-story hotel room the two men shared. He walked over to the window and opened it wide.

"You and I are going to have a talk," Dasch said, "and if we disagree, only one of us will walk out that door—the other will fly out this window."

He then revealed the truth to Burger: He had no intention of going through with the mission. He hated the Nazis, and he wanted Burger on his side when he turned the entire plot over to the FBI. Burger smiled. Having spent 17 months in a Nazi concentration camp, his own feelings for the party were less than warm. He, too, had been planning to betray the mission. They were agreed.

The two men were uncertain how best to proceed with their plan. They were reluctant to contact the authorities, having been told by their handlers that the Nazis had infiltrated the FBI. Eventually, Dasch concluded that their best option was an anonymous phone call to test

the waters and arrange for further contact. He called the FBI's New York Field Office, and after several transfers was put in touch with a special agent. Identifying himself as "Pastorius," Dasch carefully recited his story. Then, ominously, the man on the other end of the line hung up. Dasch was stricken with panic. Had he just exposed himself to a Nazi spy? Had the call been traced?

In fact, he had been speaking to the office's "nut desk," the post responsible for fielding calls from Cleopatra and the wolfman. In the midst of the most

"You and I are going to have a talk," Dasch said, "and if we disagree, only one of us will walk out that door—the other will fly out this window."



■ Some of the perpetrators of Operation Pastorius, including Dasch (upper left) and Burger (bottom center).

important case in the Bureau's history, the agent on duty had dismissed their only lead as a prank.

Shaken but not discouraged, Dasch ordered Burger to stay put and keep an eye on the other men while he headed for Washington, D.C., to set things straight. The morning of June 19, a week after his landing at Long Island, Dasch stepped into the FBI's headquarters carrying a briefcase. He explained who he was and asked to speak with Director Hoover. After spending some time being bounced from office to office, Assistant Director D. M. Ladd, the agent in charge of the manhunt, finally agreed to humor him with five minutes of his time. Dasch angrily repeated his story, only to find himself greeted with patron-

izing nods and glances toward the door. Fed up at last, he lifted the briefcase he had been carrying, tore open its straps, and dumped the entire \$84,000 of remaining mission funds onto the Assistant Director's desk. Ladd blinked with astonishment and began to reconsider Dasch's claims.

For the next week, Dasch was the subject of an intense interrogation, and he happily revealed all he knew. His operation, he explained, was just the first of a long series of sabotage missions planned by the Germans to cripple the American war effort. The second team was expected imminently, and more were scheduled to land every six weeks. Dasch exposed the targets he had been instructed

to hit as well as the methods he had been trained to use. He revealed key information about German war production, plans, and equipment. He turned over a handkerchief upon which the names of local contacts had been written in invisible ink. Most important of all, Dasch disclosed the locations of his three accomplices and their aliases, taking care to note Burger's role in the defection.

The three men who had landed with Dasch were quickly located using the information he'd supplied. Dasch knew little about the second four-man team, but with the help of his spy handkerchief, they were soon tracked down and arrested. Just two weeks after the first landing, and without a single attempt at sabotage, all eight men were in custody.

Hoover broke the media blackout on the evening of June 27. Across the nation, American citizens were astonished to wake up to front-page headlines declaring "U-BOATS LAND SPIES; EIGHT SEIZED BY FBI." But it wasn't the story known to those on the inside. Hoover reasoned that letting the truth be known now would do nothing to discourage the Germans from making further sabotage attempts. It was better to perpetuate the myth of an invincible FBI that had halted the plot through its own ingenuity and all-seeing eye.

At his press conference, Hoover made no mention of the defection of Dasch or indeed of any details on how the case was broken. "The detective work of the century," Hoover called it, referring perhaps to Agent Ladd's astute observation of \$84,000 cash bouncing off his forehead. Further details, he explained, would have to wait until after the war. The unsatisfied press room erupted with speculations about elite FBI agents infiltrating the Gestapo and the High Command. Hoover refused to confirm any such wild theories, but a series of triple-eyebrow raises, exaggerated winks, and conspiratorial elbow nudges encouraged the reporters to adopt their own conclusions.

With the last of his accomplices rounded up, it was time at last for Dasch to get his due. On July

3, his contacts at the FBI greeted him with smiles and handcuffs, and tossed him into a cell alongside his men. It was not the response Dasch had been expecting, but the arresting agents assured him it was merely a formality. If he just went along with it, he was told, J. Edgar Hoover would ensure that he received a presidential pardon within six months.

Hoover had indeed already spoken to President Roosevelt about the arrest, but his conversation had nothing to do with advocating Dasch's release. The President was given an account similar to the one furnished to the press, with no mention of Dasch or Burger's role in the investigation. According to Hoover, Dasch had been "apprehended" two days after his accomplices; and the arrest had been made in New York, not Washington, implying that the arrest of the subordinates had led to the capture of their leader rather than the other way around.

Since the infiltrators hadn't actually committed any crime, a normal court could sentence them to at most a few years in prison—or even acquit them entirely. To President Roosevelt, this was unacceptable. In a memorandum sent to Attorney General Biddle, he wrote: "Surely they are as guilty as it is possible to be and it seems to me that the death penalty is almost obligatory." A military tribunal, he felt, was the only way to ensure this outcome. "I won't give them up," he told Biddle. "I won't hand them over to any United States marshal armed with a writ of habeas corpus."

He would find no objections among the American populace. As shown in polls and editorials across the country, the general public was overwhelmingly in favor of execution for all eight infiltrators. A letter printed in one newspaper called for the men to be fed to Gargantua, the Ringling Brothers' famous giant circus gorilla.

Within a month of the initial landing at Long Island, the eight saboteurs were put before a closed-door U.S. military tribunal—the first to be assembled since the days of the Civil War. It was presided over by a panel of seven generals; there would be no

jury, no press, and no appeal. During the trial, none of the defendants denied their involvement with the plot, instead claiming that they were forced into the mission by the Nazis or that they had joined as a means to escape from Germany. Due to his unique circumstances, Dasch was defended separately. His counsel argued competently in his favor, noting that the case would never have been broken without him, that the FBI had promised him his freedom, and that he clearly had been planning to betray the mission from the start.

After 16 days in session and two rejected constitutional appeals from the defense, a verdict was signed and sent directly to the President, who was to be the final arbiter of the sentencing. It was unanimous: the Germans, all eight of them, were guilty. The recommended sentence was death.

A letter printed in one newspaper called for the men to be fed to Gargantua, the Ringling Brothers' famous giant circus gorilla.

It was only upon reading the transcript of the trial that Roosevelt learned how Hoover had misled him. Regardless, it apparently didn't shake the foundation of his opinion on the case. At the urging of defense counsel, FDR gave only enough ground to commute Dasch's sentence to 30 years of hard labor and Burger's to life. George John Dasch, a man who had envisioned himself being welcomed as a hero by the American people and perhaps earning the Medal of Honor, would instead spend what was likely to be the rest of his life in prison. His six accomplices were

not so fortunate. Five days after the trial's end, they were marched to the electric chair in alphabetical order. Within two months of landing in America, the men had been captured, charged, tried, and executed. The official verdict of the tribunal wouldn't be released for another three months.

Dasch and Burger were locked away in a federal penitentiary, their true story only known to a handful of military and government officials. But as ethically suspect as J. Edgar Hoover's deception may have been, his cover-up worked. Hitler was infuriated at the news of his men's capture, and he refused to risk another submarine for further missions. Just as he had intended, Hoover's plan effectively stopped any attempts at German sabotage for the remainder of the war.

Burger and Dasch's stories didn't end in prison. After the Allied victory in Europe, the documents pertaining to their case were released to the public despite the strenuous objections of J. Edgar Hoover. With the truth out in the open, and after a further three years of squirming, President Harry S. Truman finally agreed to commute the two men's sentences. Having spent six years in federal prison, they were released and deported to Germany.

Stepping off the plane onto German soil, Dasch and Burger found themselves two men without a home: criminals in America and traitors in Germany. Burger turned against his former commander, publicly blaming him for the entire debacle before disappearing several years later. For his part, Dasch refused to run; he spent the rest of his life campaigning for acceptance in Germany and for a chance to return to America. He never received either. Dasch died in Germany in 1992, still awaiting the pardon promised him by J. Edgar Hoover half a century earlier.

ORION: THE ATOMIC SPACESHIP

Ride the bomb into the great unknown

The year was 1957. Although man was the master of the Earth, only once had he managed to send an object beyond the confines of the atmosphere, in the form of a beachball-sized spacecraft called Sputnik. The trailblazing German rocket scientist Werner von Braun had drawn up plans for spacecraft that would launch humans into orbit, but even then it was clear that even the best chemical rockets would only allow a handful of explorers to visit a relatively small segment of the solar system. Other star systems were well out of reach, and most of mankind would be mere spectators.

Fresh from their success with the atomic bomb, a small team of Manhattan Project physicists gathered to try and change all that. Working in secret within the brand-new United States Advanced Research Projects Agency (ARPA, now called DARPA), they designed and tested an enormous and enormously ambitious nuclear spaceship concept that would have made everything the Soviets and NASA were doing seem like hobby rockets in comparison. The code name was *Project Orion*.

Project Orion was intended to harness nuclear energy in its rawest form: by detonating a series of nuclear bombs in rapid succession to propel huge spaceships from the Earth into the heavens. The largest of the envisaged Orions was to be seven million tons—more than 7,000 times more massive than the Space Shuttle—with accommodations for hundreds of passengers. Given enough bombs, an Orion spaceship theoretically could have reached one tenth the speed of light, enabling interstellar travel.

Shortly after the second World War, as the dust was still settling over Hiroshima and Nagasaki, sci-

entists and engineers almost immediately began working to harness nuclear energy for nondestructive purposes. Two former Manhattan project physicists—Stanislaw Ulam and Freeman Dyson—approached the General Atomics division of the General Dynamics Corporation with their earthshaking Orion concept. Intoxicated by the heady aroma of a new age, General Atomics hired Ulam and Dyson to develop their nuclear spaceship.

The largest of the envisaged Orions was to be seven million tons—more than 7,000 times more massive than the Space Shuttle—with accommodations for hundreds of passengers.

Pulp science-fiction had invoked a vague “atomic drive” as early as the mid-1930s, but after the awe-

some and terrifying specter of mushroom clouds in Japan, the very idea of nuclear explosions being harnessed for useful purposes seemed ridiculous. But Ulam and Dyson's designs, however, were surprisingly sound, and their early calculations were very encouraging.

The fundamental design of a Project Orion spacecraft consisted of four parts: a payload of nuclear bombs, propellant, a pusher plate, and a spaceship. During launch from the Earth's surface, the nuclear bombs would be rapidly detonated behind the Orion craft at precalculated distances. The plasma from these explosions would expand into a cigar shape toward a heavy metal plate at the base of the ship, pushing the Orion spaceship forward.

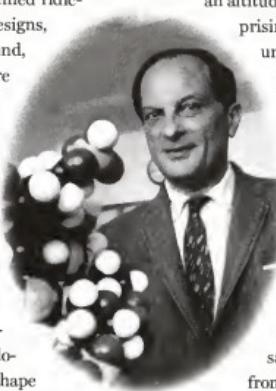
Project Orion was fueled by the raw intellectual prowess and unerring faith in technology held by some of the world's most brilliant people.

Representatives of the General Dynamics Corporation brought the Project Orion concept to ARPA in 1958, and were awarded a contract to research the technology. The project's budget was tiny compared to the overall budget of General Dynamics, nevertheless within a year the Orion team had completed calculations that indicated the project was feasible. In the next few months, a series of scale-model experiments called "putt-putts" were conducted with the high-powered chemical explosive C4. The first few designs were

unable to withstand the explosive tests, but in November 1959 a putt-putt called Hot Rod flew to an altitude of 100 meters. The flight was surprisingly stable and the craft was nearly unscathed, lending strong evidence to the technical feasibility of a bomb-powered drive system. The motto of Project Orion became "Mars in 1965, Saturn in 1970."

A full-size Orion vehicle would have had a mass of 4,000 tons with a pusher plate about one meter thick at the center. This wall of metal would serve to reflect the Orion craft away from the nuclear explosions, while at the same time protecting the passengers from the neutron radiation. The enormous shock absorbers between the pusher plate and the crew module would then distribute the 10,000 Gs of each nuclear blast to something much more comfortable for Orion's passengers. In fact, an Orion launch would probably be much more comfortable than a conventional chemical rocket because of the sheer mass of the vehicle.

Consider the launch of a hypothetical Orion spaceship propelled by four-kiloton bombs. The need for observers to wear protective eyewear would be immediately evident as the enormous ship becomes engulfed in a fireball more intensely bright than the surface of the sun. A rapid series of massive explosions would create a column of fast-expanding plasma, pushing the vehicle up into the atmosphere. Within one minute, as the craft accelerates, the plasma column would start to break up into distinct flashes of light every few thousand feet. Several minutes later, the final flash



Creators of the Orion concept, Stanislaw Ulam (top) and Freeman Dyson (bottom).

would cap a string of enormous, fiery pearls arching gracefully into space as the Orion reaches orbit. For observers at a safe distance, the entire launch would have been completely silent. But a pressure wave would reach them a few seconds after the Orion's launch was complete, causing a several-minutes-long series of thundering explosions that would sound like the coming of the apocalypse.

Given all this, it is small surprise that the launch of the Orion was the greatest technical hurdle to its success. A single Orion launch would have left a trail of fallout across a tremendous swath of the land or sea, the radiation from its bombs would have charged the ionosphere and disrupted the natural radiation belts around the Earth. Moreover, the series of electromagnetic pulses from the larger proposed designs would have incapacitated all electronics within hundreds of miles of the launch site. The General Atomics physicists realized that solving these problems was crucial for the viability of the project.

A single Orion launch would have left a trail of fallout across a tremendous swath of the land or sea.

While they worked feverishly at overcoming the technical challenges, political forces were moving against the project. The support of NASA, the fledgling national space agency, was essential. In early 1963 it seemed that the organization might embrace Orion: Notable NASA engineers such as Werner von Braun consulted on the project, and

collaborations involving smaller Orions launched atop modified Saturn V vehicles were proposed. However, the agency's administration never came around to the radical idea, and Project Orion was soon orphaned.



■ Fast fission to the final frontier—an artist's rendering of Project Orion.

such a vehicle could ever be made safe. In addition, it was clear that every launch of an Orion would have had a massive impact on the environment.

Though Project Orion is long dead, the idea of a pulse-detonation nuclear spaceship is still alive. To some, the idea of discarding our flimsy aluminum/carbon rockets in favor of such battleship-sized behemoths is deeply romantic. More pragmatic supporters suggest a version of Orion assembled in orbit, thus avoiding most of the environmental dangers. Others have developed the concept further: The British Interplanetary Society proposed an ambitious design for an unmanned interstellar probe—Project Daedalus—which would have utilized Orion-style nuclear-pulsed propulsion to reach a neighboring star system within the span of a human lifetime. One thing is certain: Orion is one of very few seriously proposed spacecraft capable of reaching the speeds necessary for real-live people to explore the outer solar system. If mankind wishes to go beyond our cosmic backyard and explore the stars, this mothballed atomic-age technology may yet be our best chance.

THE MEAT-O-MATIC

As scientists optimistically prepare for long-term spaceflight, one area of research includes the development of meat-on-demand machines. Scientists have demonstrated that chunks of animal muscle can be grown inside vats of nutrient-rich fluid, providing a good source of protein on long journeys. It isn't very appetizing, however, when one considers that the resulting meat is essentially a cultured muscle tumor.

Space travelers' vat-meat could be grown on thin, flat membranes and then stacked to achieve thickness, or it could be cultured on tiny beads then harvested and made into processed meats like chicken nuggets or ground beef. Either way, to get the taste and texture right, the meat would need to be stretched and exercised as it goes, just like a real animal muscle would be.

Even if the technology never makes its way onto interstellar spacecraft, it has plenty of applications on Earth. This technology could spell the end of moral vegetarianism, since animals would no longer be part of the meat-producing process. The unhealthy fatty acid Omega 6 could also be replaced with Omega 3, making tumor-chow healthier than the flesh of real beasts. But the technology raises some interesting questions . . . For instance, would it be acceptable to use one of these machines to produce meat based on human muscle tissue? Practically speaking, human meat is extremely nutritious to humans, and such vat-grown manburgers would not have originated from a human.

If the world ever embraces the concept of "in vitro" meat, a meat-o-matic might become a common kitchen appliance, producing whatever meat one desires from a small packet of "seed" cells. Gone would be the concerns of animal welfare, slaughterhouse cleanliness, and livestock-related environmental impact. In theory, one cell of meat could be cultured enough to provide for the meat demands of the entire world.



OUTER SPACE EXPOSURE

What really happens when a human ventures into space without a space suit



In scores of science fiction stories, hapless adventurers find themselves unwittingly introduced to the vacuum of space without proper protection. The unlucky space traveler often emits an alarming cacophony of screams and gasps as their increasingly bloated body writhes and spasms. Soon his exposed veins and eyeballs bulge in a disagreeable manner. Without rescue, the ill-fated adventurers rapidly swell like over-inflated balloons, ultimately bursting in a gruesome spray of blood.

As is so often true, this popular culture representation does not reflect the reality of exposure to outer space. In the 1960s, as technology turned the dream of manned spaceflight into reality, engineers recognized the importance of determining the amount of time astronauts would have to react to integrity breaches such as a damaged spacecraft or punctured space suits. To that end, NASA constructed an assortment of large altitude chambers to mimic the hostile environments found at varying distances above the Earth, accounting for factors such as air pressure, temperature, and radiation. Using the data from these experiments, scientists have constructed a pretty clear picture of what would happen if an unprotected human slipped into the cold, airless void of outer space.

A series of accidents over the years proved most of their extrapolations to be accurate. In a 1965

space-suit test gone awry, a technician in an altitude chamber became perhaps the first human in history to be exposed to a hard vacuum. His defective suit was unable to maintain a safe pressure, and the subject collapsed to the floor after 14 breathless seconds. The chamber was immediately repressurized, and he regained consciousness shortly thereafter. NASA physicians were relieved to find that he had not suffered any detectable injury. In a later incident, another technician spent four minutes trapped at a very low pressure when his altitude chamber malfunctioned. He lost consciousness and began to turn blue, but escaped death when a manager kicked in one of the machine's glass gauges, allowing air to seep into the chamber.

In 1971, three Russian cosmonauts aboard an early Soyuz spacecraft tragically experienced the vacuum of space firsthand, as described in the *Almanac of Soviet Manned Space Flight*:

"...the orbital module was normally separated by 12 pyrotechnic devices which were supposed to fire sequentially, but they incorrectly fired simultaneously, and this caused a ball joint in the capsule's pressure equalization valve to unseat, allowing air to escape... This caused the cabin to lose all its atmosphere in about 30 seconds while still at a height of 168 kilometers. Patsayev realized the problem and unstrapped from his seat to try and cover the valve inlet and shut off the valve, but there was little time left. It would take 60 seconds to shut off the valve manually and Patsayev managed to half close it before passing out. Dobrovolsky and Volkov were powerless to help, since they were strapped in their seats, with little room to move in the small capsule and no real way to assist Patsayev. The men died shortly after passing out. [...] The rest of the descent was normal and the capsule landed at 2:17 a.m." ♦

Science now knows that a number of problems begin to occur when the human body is suddenly exposed to the vacuum of space. Though the damage is relatively minor at first, injuries rapidly accumulate into a life-threatening combination. The first effect is the expansion of gases within the lungs and digestive tract due to the sharp reduction of external pressure. Air stored in the lungs rushes out through the nose and mouth, while the pockets of gas in the lower intestine are rapidly expelled as space flatulence. Though a human will reflexively attempt to hold his or her breath in an airless environment, a victim of explosive decompression greatly increases

his chances of survival simply by exhaling within the first few seconds. If he does not, death is likely to occur when the lungs rupture and spill bubbles of air into the circulatory system. Such a life-saving exhalation might be due to a shout of surprise, though it would naturally go unheard without air to carry it.

Since liquid water spontaneously converts into vapor in the absence of atmospheric pressure, a space-exposed human would experience the rather strange sensation of the moisture on his eyes and mouth boiling away. The same effect would cause water in the muscles and soft tissues of the body to evaporate, swelling some parts of the body to twice their usual size after a few moments. This bloating may result in some bruising due to bro-



■ Warning: space suits must be worn at all times.

ken capillaries, but would not be sufficient to break the skin.

Within seconds the reduced external pressure would allow otherwise-harmless nitrogen dissolved in the blood to form gaseous bubbles, a painful condition known to divers as "the bends." Direct exposure of the skin to the sun's ultraviolet radiation would also cause a severe sunburn. Fortunately heat does not transfer out of the body very rapidly in the absence of a medium such as air or water, so despite the extreme cold of outer space, freezing to death is not an immediate risk.

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For about the first ten seconds—a long time to be loitering in space without protection—an average human would be rather uncomfortable, but would still have his wits about him. Depending on the nature of the decompression, this may give a victim sufficient time to take measures to save his life. But this period of "useful consciousness"

wanes as the effects of brain asphyxiation begin to set in. In a vacuum, the gas exchange of the lungs works in reverse, dumping oxygen out of the blood and accelerating the oxygen-starved state known as hypoxia. After about ten seconds a victim will experience loss of vision and impaired judgment, and the cooling effect of evaporation will lower the temperature in the victim's mouth and nose to near-freezing. Unconsciousness and convulsions would follow several seconds later, along with a blue discoloration of the skin called cyanosis.

At this point the victim would be in a blue, bloated, unresponsive stupor, but his brain would remain undamaged and his heart would continue to beat. If pressurized oxygen was administered within about one and a half minutes, a person in such a state could likely make a complete recovery, though the hypoxia-induced blindness may not pass for some time. Without intervention within 90 seconds, however, the blood pressure would fall sufficiently that the blood itself would begin to boil and the heart would stop beating. There are no recorded instances of successful resuscitation beyond that threshold.

Though an unprotected human would not long survive in the clutches of outer space, it is remarkable that survival times can be measured in minutes rather than seconds, and that one could endure such an inhospitable environment for almost two minutes without suffering any irreversible damage. The human body is indeed a resilient machine.

PECULIAR PARASITES

Just be glad these opportunistic creatures don't go for humans

Although parasites are an unpleasant and unavoidable part of the Earth's ecosystem, their resource-stealing nature is merely a nuisance—most of the time. For an unfortunate few members of the animal kingdom, however, the consequences of an invading parasite can be rather horrifying.

TONGUE IMPOSTOR The only parasite known to actually replace a working organ, *Cymothoa exigua* is the stuff of nightmares. The spotted rose snapper, a fish native to California, is its prey of choice. The small parasitic crustacean enters the fish's mouth and leeches blood from the snapper's tongue until the muscle dies. It then attaches itself to the leftover tongue-stump and takes over. It spends the rest of its life acting as a stand-in tongue and living off its unfortunate host.

BARBAROUS BARNACLE Another parasite fond of mind control is the *Sacculina* genus of barnacles. When the female *Sacculina* finds a suitable crab to infest, she will crawl along its body until an opening is found—usually at a joint. Once inside, the barnacle begins her grim work. By forcing long tendrils into the crab's body, she gradually gains control over her victim. She also cracks open a hole in the crab's back that allows a male *Sacculina* to take up residence with her. Once the male arrives, the crab is quickly filled with millions of eggs. As if that wasn't bad enough, there are other physiological affects that are devastating to the host. The infected crab loses its ability to regenerate lost claws, as well as its ability to reproduce. If the crab is a male, the *Sacculina* actually changes its hormone levels and behavior—effectively turning it into a female. The crab essentially becomes a slave, its only job to care for the larvae being produced in its shattered body.



WATER-LOVING WORM *Spinochordodes tellinii* is a stringlike parasitic worm that grows to an average of a meter long. It prefers damp areas, so once it has infected a host, usually a grasshopper or cricket, it uses its newfound mobility to its advantage. Controlling the host by some unknown mechanism, the worm forces the creature to seek out water and drown itself—thereby returning *tellinii* to its favorite habitat. In the event that the host is eaten, the parasite can squirm free of the hunter's body and return to taking over other naive insects.

WILEY WASP The *Plesiometra argyra* spider of Costa Rica lives every day blissfully unaware of the horrifying death that could be hovering just overhead at any moment. While the spider is usually the hunter rather than the prey, there is one species of wasp known as *Hymenoepimecis argraphaga* that targets these orb spiders regularly. A successful attack leaves the spider paralyzed as the wasp lays its eggs in its victim's abdomen. After the wasp has flown off, the spider wakes up and spends two weeks going about its normal business. All the while, the wasp larvae grow in the spider's belly, feeding off its juices. A day before its impending death, the spider suddenly stops creating its usually elaborate five-step web and begins a new two-step process that results in a very different structure. Small and strong, the new web is ideal protection for the maturing larvae. Once it's finished, the wasps kill their host and take up residence in their sturdy new web-house. While scientists aren't sure exactly how the larvae control the spider, research indicates a fast-acting chemical is the culprit.

SINISTER SPORES *Cordyceps unilateralis* is a mind-controlling fungus that has an appetite for ants. When *C. unilateralis* chances upon an ant, it invades the unfortunate host through holes in its exoskeleton and gorges itself on the soft tissues within. Once the fungus has had its fill of ant-meat, it migrates into the host's brain and takes control by altering its perception of pheromones. Stripped of free will, the zombified ant climbs to the top of a plant and latches its mandibles onto the stem. Over several days the fungus spores sprout from the ant's head, and finally these "fruiting bodies" explode, killing the host and releasing the fungus into the air. It's perch high on a plant stem ensures widespread distribution among other unfortunate ants. (For more on another ant-invading parasite, see page 90.)

FLY HIJACKER The botfly—a husky, hairy fly that resembles a bumblebee—is a resident of the warm-and-wet climates of South America. What makes this otherwise ordinary fly fascinating is its method of reproduction. When a female botfly has some eggs ready for incubation, she

hijacks a hapless mosquito in midair, and uses her sticky secretions to glue her eggs to the captive insect. She then sets it free. When the egg-laden mosquito bites an animal, the warmth of the animal's body triggers an egg to hatch, and the tiny botfly larva burrows into the skin. The larva lurks there in the subcutaneous layers for about eight weeks, forming a blister-like lump on the skin. When the botfly is ready for its final stage of development, the 1-2 centimeter worm-like pupa emerges and falls into the soil. Another

week, and the new adult fly is ready to hijack a mosquito of its own. The larvae of one species of the botfly—*Dermatobia hominis*—happily attacks humans when the opportunity arises, often in dark and damp places.



THE PEPCON DISASTER

How a minor welding accident turned into a conflagration of epic proportions



Just before lunchtime on May 4, 1988, at a facility near Henderson, Nevada, a panicked maintenance crew could be seen dashing away from the site of the Pacific Engineering Production Company, also known as PEPCON. Behind them, a moderate but ambitious-looking fire was establishing itself in a storage lot.

The crew had been repairing a wind-damaged fiberglass building when a stray spark from their welder somehow managed to set fire to the structure. The men fetched some water hoses and attempted to douse the flames, but the flourishing fire mocked their efforts. The flames soon began to fondle the 55-gallon drums stored nearby. With this alarming development, the crew abandoned their hoses and made a hasty departure. The workers knew exactly what was in the barrels, and they didn't wish to be present to observe how it would react to the flames.

At that time, PEPCON was one of the only U.S. producers of the chemical ammonium perchlorate, a key ingredient in the rocket fuel used for space-shuttle boosters and Titan missiles. This white granular compound is a powerful oxidizer, and its purpose is to accelerate rocket fuel



■ The smoke plume from the explosion rose 1,000 feet into the sky.

combustion. Also present at the facility were bulk quantities of other hazardous materials used in manufacturing, such as hydrochloric acid and nitric acid.

The *Challenger* explosion 15 months earlier had prompted NASA to freeze the space shuttle program pending investigation, yet the United States government continued to contract PEPCON at pre-Challenger quantities. Consequently, the containers full of the unused fuel component had slowly accumulated, making the site pregnant with stored energy. There were more than 4,000 tons of ammonium perchlorate in the storage area that day, so the workers fled with great enthusiasm.

Over the years, the entire facility had become peppered with residue from the ammonium perchlorate. Stiff winds on this particular day conspired against the workers, and quickly turned a small

welding accident into a brilliant orange fireball. As news of the fire spread, most of the employees rushed to evacuate the six buildings, but a man named Roy Westerfield stayed behind and called 911.

“Dispatcher: Fire department.

Westerfield: Emergency. We need the fire department, all you can get here. Immediately.

Dispatcher: What's the problem?

Westerfield: Oh, we've got . . . everything's on fire.”

At about the same time, the chief of the Clark County Fire Department noticed the column of smoke on the horizon and ordered his units to go to the location immediately. He clambered into his car and raced to the scene ahead of the fire trucks. Soon he began to see dozens of anxiety-stricken PEPCON employees along the road, hurrying away from the facility on foot in spite of the midday desert heat.

A few minutes later, as the chief neared the cluster of flaming buildings, he was blinded by an abrupt flash. The car rocked and windows exploded as the vehicle was slammed by a deafening shock wave. As the explosion's echoes slowly faded, the fire chief stopped to assess the situation and tend to a few cuts caused by the hail of broken glass. Moments later a badly damaged vehicle approached from the direction of the plant, and its driver paused alongside the chief just long enough to warn him that the worst of the explosions were probably yet to come.

Realizing that the inferno had grown far beyond his department's fire-suppression capabilities, the chief turned his car around and headed back toward Henderson. The fire engine crews had reached the same dismal conclusion, so the firefighters pulled their trucks off the road about a mile from the disaster-in-progress and watched the towering flames from afar.

In the mountains near PEPCON, an engineering crew was performing routine maintenance on a television tower when they spotted the eerily brilliant fire and began filming. They watched the dis-

tant explosion in awe, and about four minutes later, as they continued to film, they saw the PEPCON site completely disappear in a spectacular burst of energy that dwarfed the initial blast. Their vantage point afforded them a perfect view of the compression wave as it radiated across the desert, mowing down brush and demolishing a marshmallow factory adjacent to PEPCON. When the sound of this second blast reached them, it was thunderous.

PEPCON's six buildings were totally destroyed. Where they had once stood was nothing but mangled metal, overturned cars, and a 15-foot-deep crater.

The Clark County fire chief was still trying to put distance between himself and the facility when the second explosion occurred. The blast wave swept in rapidly from behind and clobbered his wounded car, momentarily smothering him in an avalanche of noise and pressure. When the moment passed, he was astonished to find that the vehicle was still somewhat operational. He continued his retreat and eventually limped his injured automobile past the columns of idling fire engines, their pulverized windows littering the roadway. By the time he reached town and found his way to the hospital, there were already hundreds of people gathered there awaiting treatment. The explosion had dislodged parts of buildings and shattered windows in town—one and a half miles away—causing many instances of trauma and lacerations from flying debris.

On the horizon, a plume of smoke rose 1,000 feet into the sky, and the column was said to be visible from as far as a hundred miles away. Some distant observers reportedly wondered whether this mushroom cloud indicated that the long-running Cold War had finally progressed into a Hot War.

The frenzied inferno at PEPCON finally calmed once the explosions consumed the majority of the fuel. The cataclysmic blasts had ripped a hole in the ground and set a gas line ablaze, but the resulting 200-foot-tall flame was easily starved to death by shutting off the gas feed from a station a mile away. Investigators arrived to survey the damage and found utter devastation. PEPCON's six buildings were totally destroyed. Where they had once stood was nothing but mangled metal, overturned cars, and a 15-foot-deep crater. The neighboring marshmallow factory had also been reduced to a twisted ruin. Many structures in the area—some as far as ten miles away—suffered damage, mostly in the form of shattered windows, cracked walls, and doors that were blown from their hinges.

Though almost 400 injuries were reported—both from ground zero and from Henderson residents—surprisingly there were only two deaths. One was a worker confined to a wheelchair who had been unable to exit from the PEPCON building quickly enough. The other was Roy Westerfield, the very man who had made the original 911 call. He had been handicapped by the effects of polio and was unable to walk well. It is generally believed that he opted to stay behind and alert the authorities, knowing that a successful escape was unlikely.

An investigation of the event found that the destructive energy from the larger explosion was roughly equivalent to 1,000 tons of TNT. It caused seismograph needles to dance as far away as

Colorado, where the sensitive equipment measured the distant tremor as a 3.5 on the Richter scale.

PEPCON lawyers responded quickly, attempting to pin the blame on the Southwest Gas company. The lawyers claimed that the natural gas fire occurred first, causing the subsequent ammonium perchlorate explosions. Three days after the disaster, one of the attorneys claimed, "Nothing ignites ammonium perchlorate. It does not burn. It is not flammable." Though the compound was not considered to be an extreme explosive threat before the PEPCON disaster, chemists pointed out that the attorney's grasp of chemistry must be as flimsy as his grasp of ethics. They described the chemical as "unstable and highly flammable."

PEPCON had only \$1 million in insurance, a policy which was grossly insufficient to pay for the damage to others' property. A colossal courtroom battle ensued, involving dozens of insurance companies and more than 50 law firms. The outcome of this massive orgy of justice was one million pages of depositions and a \$71 million settlement that was divided among the victims and their families.

PEPCON never rebuilt the Henderson site. The company changed its name to Western Electrochemical Co. and built a new ammonium perchlorate plant in Cedar City, Utah, which remains in operation today. Its safety record has certainly improved since the 1988 disaster. To date, there has only been one deadly explosion at the new facility.

THE PHOBIA FACTORY

How Dr. John B. Watson made a healthy baby boy fear cuddly animals in the name of science

In the early decades of the 20th century, the discipline of psychology was still in its infancy but beginning to make significant headway. Pioneering researchers were enthusiastically unraveling the human mind, and some were willing to go to alarming lengths to satisfy their curiosity.



One such trailblazer was a behaviorist named John B. Watson. In 1919, his curiosity was aroused after observing a child who showed an irrational fear of dogs. Watson supposed that a shiny new human would not possess an inborn fear of domesticated animals, but if "one animal succeeds in arousing fear, any moving furry animal thereafter may arouse it." In order to explore this theory, he undertook a series of experiments at Johns Hopkins University to determine whether an infant could indeed be conditioned to fear cute-and-cuddly animals by associating them with scary stimuli. A couple decades earlier Pavlov's notorious dogs had been conditioned to salivate at the sound of a bell; Watson hoped to expand upon the concept.

In 1920 Watson secured access to a "healthy, stolid, and unemotional" nine-month-old infant named Albert B., the son of a wet nurse who worked in the hospital. Watson was assisted by Rosalie Rayner, a graduate student at the university. Their first order of business was to establish a psychological baseline. They tried exposing the infant to live animals such as a white rat, a rabbit, a dog, and a monkey, and Albert reached for

each animal with cheerful curiosity. The researchers brought him white, furry items such as a Santa Claus mask and clumps of cotton, and he manipulated the objects with interest. Then they placed a long steel rod behind Albert's head and struck the metal sharply with a claw hammer. He flinched with great distress. The infant's baseline reactions to these stimuli were duly noted, and two months later the peculiar series of "joint stimulation" experiments was underway. Excerpts from Dr. Watson's notes outline its progression:

Age: 11 months, 3 days

■ *White rat suddenly taken from the basket and presented to Albert. Just as his hand touched the animal the bar was struck immediately behind his head. The infant jumped violently and fell forward, burying his face in the mattress.*

■ *Just as the right hand touched the rat the bar was again struck. Again the infant jumped violently, fell forward and began to whimper.*

Age: 11 months, 10 days

■ *Rat presented suddenly without sound. When the rat nosed the infant's left hand, the hand was immediately withdrawn. It is thus seen that the two joint stimulations given the previous week were not without effect.*

■ Joint stimulation. Fell over immediately to right side and began to whimper.

■ Rat alone. The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over on left side, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before reaching the edge of the table.

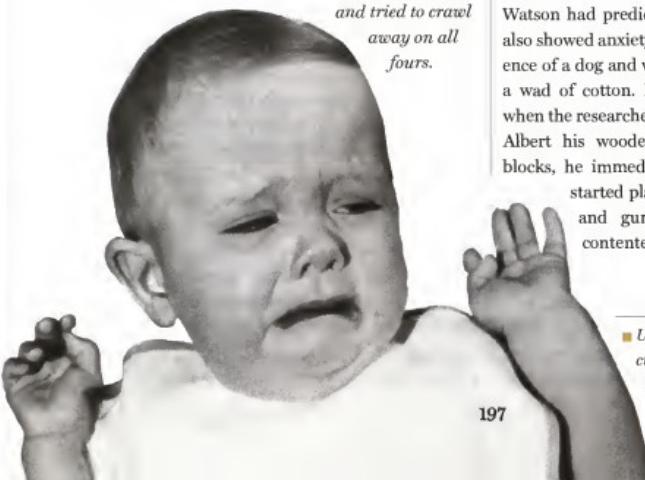
Watson also wondered whether Albert would transfer these acquired fears to other animals or objects. After a five-day furlough, additional experimentation ensued:

Age: 11 months, 15 days

■ Rat alone. Whimpered immediately, withdrew right hand and turned head and trunk away.

■ Rabbit alone. Negative responses began at once. He leaned as far away from the animal as possible, whimpered, then burst into tears. When the rabbit was placed in contact with him he buried his face in the mattress, then got up on all fours and crawled away.

■ Fur coat (seal). Withdrew immediately to the left side and began to fret. Coat put close to him on the left side, he turned immediately, began to cry and tried to crawl away on all fours.



■ [A lab assistant] brought the Santa Claus mask and presented it to Albert. He was again pronouncedly negative.

Age: 11 months, 20 days

■ Rat alone. Withdrawal of the whole body, bending over to left side, no crying. Fixation and following with eyes. It was thought best to freshen up the reaction by another joint stimulation.

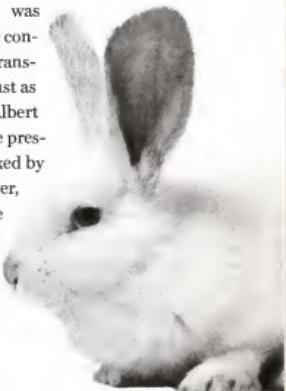
■ Just as the rat was placed on his hand the rod was struck. Reaction violent.

■ Rabbit alone. Leaned over to left side as far as possible. Began to whimper.

■ When the rabbit was left on Albert's knees for a long time he began tentatively to reach out and manipulate its fur with forefingers. While doing this the steel rod was struck. A violent fear reaction resulted.

■ Rabbit alone. Started immediately to whimper, holding hands far up, but did not cry.

Albert's profound negative response to the rabbit was taken as evidence that the conditioned fear had indeed transferred to other animals, just as Watson had predicted. Albert also showed anxiety in the presence of a dog and was vexed by a wad of cotton. However, when the researchers gave Albert his wooden toy blocks, he immediately started playing and gurgling contentedly.



■ Under the proper conditions, even cute and cuddly creatures can be terrifying.

Watson next sought to determine whether these acquired fears had any substantial staying power. The researchers granted the infant a one-month reprieve, after which they once again confronted Albert with his fuzzy phobias:

Age: 12 months, 21 days

- *Santa Claus mask. Withdrawal, gurgling, then slapped at it without touching. When his hand was forced to touch it, he whimpered and cried. He finally cried at the mere visual stimulus of the mask.*
- *Fur coat. Wrinkled his nose and withdrew both hands, drew back his whole body and began to whimper as the coat was put nearer. In moving his body to one side his hand accidentally touched the coat. He began to cry at once, nodding his head in a very peculiar manner.*
- *The rat. He allowed the rat to crawl toward him without withdrawing. The rat was then allowed to crawl against his chest. He first began to fret and then covered his eyes with both hands.*
- *The rabbit. After a few seconds he puckered up his face, began to nod his head and to look intently at the experimenter. He reached out tentatively with his left hand and touched the animal, shuddered and withdrew the whole body. The experimenter then took hold of his left hand and laid it on the rabbit's back. Albert immediately withdrew his hand and began to suck his thumb. Again the rabbit was laid in his lap. He began to cry, covering his face with both hands.*

Without a doubt, the 30-day hiatus was insufficient to expunge the artificially induced fear. One last scientific question remained: Could these con-

ditioned emotional responses be removed through laboratory methods? Watson had originally intended to end his experiment by "reconditioning" the infant to neutralize the fear response, but he ultimately opted to drop that portion of the experiment owing to a lack of time. When he published the results of his study, however, he suggested that the best reconditioning method would have been to replace the traumatizing metallic *CLANG!* with a positive stimulus such as A) physical stimulation of "first the lips, then the nipples, and as a final resort the sex organs"; B) candy or food; or C) constructive activities.

The psychological community received Watson's results with rapt fascination. Nonetheless, several months later the officials at Johns Hopkins asked Watson to resign from the university. The request had nothing to do with the questionable ethics of his baby-scaring experiments; he was dismissed because of unauthorized "experimentation" with a lovely young graduate student. Watson's wife discovered evidence that he and his assistant Rosalie Rayner had participated in unabashed physical stimulation of one another's sex organs, and consequently Watson lost his career and his marriage amid a flurry of publicity.

By modern standards, Watson's infant-phobia experiment was grossly unethical for numerous obvious reasons. The research was undertaken during the rough-and-tumble adolescence of psychology, a time when the subjects' well-being was seldom considered equal to the scientific rewards. Moreover, the experiment itself was rife with procedural flaws that rendered the results ambiguous at best. For



■ *The unethical Dr. John B. Watson.*

instance, the researchers only tested with one subject and one negative stimuli, and the tests tended to be improvised and slapdash. Although Watson himself conceded that the experiment was imperfect, he considered the results to be valuable to science. "These experiments would seem to show conclusively that directly conditioned emotional responses as well as those conditioned by transfer persist, although with a certain loss in the intensity of the reaction, for a longer period than one month," he wrote in his infamous paper. "Our view is that they persist and modify personality throughout life."

Today, the "Little Albert" experiment is the stuff of psychological legend. It has been thoroughly cited, scrutinized, expanded, and embellished since its publication in 1920. But as is true with many fundamentally flawed studies, the scientific community ultimately categorized the experiment as intriguing yet uninterpretable. Though Watson spent the rest of his career begging to differ, no

firm conclusions can be drawn from his hard-earned data—except perhaps that one should avoid employing experimental psychologists as babysitters.

The research was undertaken during the rough-and-tumble adolescence of psychology, a time when the subjects' well-being was seldom considered equal to the scientific rewards.

As for Albert, he and his mother slipped into obscurity immediately following the study and were never publicly identified. No one knows what ultimately became of the tormented infant, nor whether his repulsion of cute-and-cuddly creatures haunted him into adulthood.

PLEASURE ON DEMAND

Electrical stimulation of the brain results in unbridled euphoria

In 1953, American researcher James Olds made a fortuitous discovery while scrutinizing rodent brains at the Montreal Neurological Institute. A particular rat was outfitted with a brain electrode in its hypothalamus, a region known to produce profound unpleasantness when stimulated. Olds was trying to determine how quickly the rat would associate actions with punishment, so he activated the electrode whenever the rat wandered into a particular corner of its cage. But unlike other zapped hypothalamuses, however, this rat's brain seemed to relish the sensation, and the animal quickly developed a preference for the neuron-stimulating corner. In 1956 Olds wrote about the experimental accident for *Scientific American* magazine:



■ A neuro-electrical pick-me-up.

“At this point we assumed that the stimulus must provoke curiosity; we did not yet think of it as a reward. Further experimentation on the same animal soon indicated, to our surprise, that its response to the stimulus was more than curiosity. On the second day, after the animal had acquired the habit of returning to corner A to be stimulated, we began trying to draw it away to corner B, giving it an electric shock whenever it took a step in that direction. Within a matter of five minutes the animal was in corner B. After this the animal could be directed to almost any spot in the box at the will of the experimenter. Every step in the right direction was paid with a small shock; on arrival at the appointed place the animal received a longer series of shocks.”

When Olds removed the electrode, he discovered the cause for the unexpected behavior: The wire had narrowly missed

the hypothalamus and ended up in the septum instead. The specific functions of the septum were still a mystery to science, but the misplaced electrode implied that it must play some role in the brain's reward/pleasure system.

Olds and his colleague Peter Milner spent years exploring the serendipitous discovery. They found that wired lab rats could be coaxed into completing complex mazes and taking life-threatening risks when septum stimulation was the reward. The researchers also built an apparatus where an animal could zap its own pleasure centers with a lever, and once an animal learned how the mechanism worked, it would soon pass out from pleasure-induced exhaustion.

Between 1950 and 1952, several years before Olds's fortuitous finding, Dr. Robert G. Heath was experimentally implanting similar depth electrodes into human brains. Most of his subjects were mentally ill patients from state hospitals. Despite other scientists' concerns that his tests were unethical, he was unrelenting in his efforts to understand—and perhaps repair—malfunctioning minds. In 1954, when Olds and Milner published their findings on the pleasure-producing properties of the septum, Heath redirected much of his research to that region. He found that the human reaction to electronic stimulation of the septal area was quite similar to that of laboratory animals—the head-wired subjects experienced immediate, profound gratification.

Authors Judith Hooper and Dick Teres were shown some video footage of Heath's experiments, and they recounted the experience in their book, *The 3-Pound Universe*:

“A woman of indeterminate age lies on a narrow cot, a giant bandage covering her skull. At the start of the film she seems locked inside some private vortex of despair. Her face is as blank as her white hospital gown and her voice is a remote, tired monotone.”

“Sixty pulses,” says a disembodied voice. It belongs to the technician in the next room, who is sending a current to the electrode inside the woman’s head. The patient, inside her soundproof cubicle, does not hear him.

Suddenly, she smiles. “Why are you smiling?” asks Dr. Heath, sitting by her bedside.

“I don’t know . . . Are you doing something to me? [Giggles.] I don’t usually sit around and laugh at nothing. I must be laughing at something.” “One hundred forty,” says the off-screen technician.

The patient giggles again, transformed from a stone-faced zombie into a little girl with a secret joke. “What in the hell are you doing?” she asks. “You must be hitting some goody place.” ☺

Some of Heath's patients were also furnished with a cannula—a tube to deliver precise doses of various chemicals to the brain. Many chemicals

HAPPY AS A CHARGING BULL

In 1963, physiologist Dr. Jose Delgado made one of the most striking demonstrations of the power of brain electrodes. In the Spanish city of Cordoba, before throngs of spectators, the scientist strolled into a bull ring adorned in full matador attire. He flapped his red cape at the bull on the opposite side of the arena, and it carried out its characteristic ferocious charge. When it was within a few yards of Delgado, he pressed a button on his belt to energize a radio-controlled electrode that had been implanted in the bull's brain. The animal's rage evaporated instantly. It dug its heels into the dirt, skidded to a stop, and trotted away. In subsequent years, Delgado was known to use similar methods to "play" monkeys and cats like electronic toys.

caused little or no change in the subjects' behavior, but when his research team injected the neurotransmitter acetylcholine into the septum, the EEG machine registered waves of intense, orgasmic pleasure—sometimes for as long as 30 minutes—in the brains of delighted subjects.

During the 1970s Heath took the experiment even further by equipping some of his human patients with portable self-stimulators. Three or four "stimulation zones" in their brains were wired with electrodes, and a control device was mounted to their belt like an ice-cream man's change dispenser. Using this device, subjects were able to zap their brain whenever it tickled their fancy, with a built-in counter keeping a tally of how many times each site was electrified.

Unlike the self-stimulating rats, most of the humans dispensed autopleasure in sensible amounts. In 1972, however, a homosexual schizophrenic subject called B-19 used one of the devices to stimulate himself an average of 25 times per minute. When B-19 expressed that he wished to be "cured" of his homosexuality, the helpful experimenters furnished him with heterosexual pornographic films. Illuminated by the shifting light of the erotic cinema, he tapped the happy-button like a telegraph operator with an urgent message. Gradually, the idea of energizing his electrodes with the gentler sex began to grow on him. "During these sessions," Heath wrote of the experiment, "B-19 stimulated himself to a point that he was experiencing an almost overwhelming euphoria and elation, and had to be disconnected, despite his vigorous protests."



■ Dr. Robert Heath practices implanting electrodes.

Encouraged by B-19's developing interest in women, the researchers went to town. They secured the services of a "lady of night" for \$50 and explained that she would be plying her trade in a pitch-black room with a man who was connected to brain-monitoring equipment. In the ensuing experiment, subject B-19 was repeatedly stimulated, and at its conclusion the researchers considered the test to be "very successful." But the unnatural methods produced unnatural results, and shortly after the leads were disconnected his sexual orientation reverted to a preference for men.

Today, thanks to the controversial research of pioneers like Heath, modern medicine has the technology to enclose such electrodes completely within the human body. A battery pack no larger than a book of matches can be implanted into the abdomen, providing pulses to brain electrodes for up to five years between rechargings. These gadgets are a rarity, however, used only in those who suffer rare and extreme mental

maladies. Not even victims of intractable neuropathic pain or extreme depression are permitted to have their pleasure centers wired. Individuals with happiness deficits are instead treated with drugs, which are both more and less invasive depending on one's perspective. Although medications don't involve drilling holes in the skull, they do interact with the entire physiology, causing a host of unwanted chemical side effects. Often they are quite expensive, too.

Some bioethicists feel that Electrical Stimulation of the Brain (ESB) technology should be made widely available, arguing that everyone is entitled to

CANTANKEROUS MONKEY PROBLEM SOLVED

In the hierarchy of rhesus monkeys, it's good to be king. The alpha male of a rhesus colony gets to eat first and pick any female that catches his eye—but to stay alpha male, he must maintain his dominance. Most of the time, an aggressive stance and a degree of aloofness are all that matter, but if one of the other colony members gets uppity, he'll have to do more than posture—some of the old rough-and-tumble may be required.

In the 1950s, Dr. Jose Delgado kept a small colony of rhesus monkeys in his laboratory, and the alpha male of this group was a particularly cantankerous specimen named Ali. Ali was known to bite and swat at his mates, generally intimidate the group, and lord over all the food that was placed in their pen. Delgado implanted an electrode about the size of a hair into Ali's brain, and a remote control was used to deliver shocks directly to the irritable monkey's pleasure center.

When a bowl of fruit was set in the pen, Ali would be dosed with Electronic Stimulation of the Brain and would remain calm while the other primates helped themselves. A five-second jolt was enough to soothe any rage, and Ali's dominance quickly toppled, since he was too tranquil to bother intimidating his troop.

Soon the scientists grew bored of making Ali placable via remote, and instead made a lever that was placed inside the monkey pen. Any of the animals could then deliver ESB to the once intractable Ali. One particular female soon learned to pull the lever whenever Ali tried to horde the food or act aggressively. Under her deft ministrations, Ali was uninterested in food, intimidation, or sex, and allowed her and the other monkeys some peace.

the opportunity for unbridled joy. There are many, however, who fear that pleasure on demand would eventually undermine an individual's judgment and ambition, ultimately resulting in zombielike apathy. Clearly the sensation of pleasure evolved to motivate organisms to take actions that are beneficial for survival and reproduction; therefore, it is possible that an artificial joy machine would be detrimental to our race's long-term survival.

As a counterargument, some septal-electrode supporters point out that humans never seem to tire of other septum stimulations such as sex or delicious foods; and while many people naturally partake of those pleasurable activities a lot at first, most gradually moderate their self-gratification to times when it is necessary and appropriate. And

unlike sex and chocolate, this technology isn't known to cause unwanted pregnancies, disease, or weight gain. But of course an ESB-wired person could still occasionally opt to take a day off work, put a brick on the button, and enjoy an afternoon of neuroelectric bliss. Without more experimentation, there is no way to know for certain what long-term effects such technology would have upon humans.

Of course the idea of putting electrodes into the brain is still too high on the creepy scale for most people, so there is little chance that pleasure-o-matic implants will be offered as elective surgery anytime soon. But in the coming decades, when hacking the human body becomes increasingly commonplace, this sort of idea may just find some footing.

POLAND'S GERM GAMBIT

When biological warfare was used for good instead of evil

Biological warfare may well be as old as human history. Records date back at least to the 16th century B.C., when the Assyrians would pour ergot—a hallucinogenic fungus—into the wells of their enemies. In the 4th century B.C., Scythian archers used manure on their arrow-tips, ensuring debilitating infections among the wounded. In the 14th century A.D., some inventive Tartars even tried catapulting victims of bubonic plague over the walls of the besieged city of Kaffa (modern-day Feodosia). Whether their efforts were successful or whether the disease spread into the city from the camp rats is not known, but the plague came to Kaffa, and may have given rise to the Black Death in Europe as the residents fled their stricken city.



■ *Rickettsia*, the bacterium which causes typhus.

After discovering the New World, European settlers brought smallpox to the Native Americans, demonstrating the havoc that outside diseases can bring upon nations. A few centuries later, Europeans attempted to use biological warfare to their advantage during World War I. The 1925 Geneva Protocol attempted to limit biological warfare, but only with mixed success. Even today, biological weapons are still researched worldwide. From the earliest crude poison to modern anthrax and ebola, every attempt at biological warfare has been essentially aggressive—the idea has always been to incapacitate or kill the enemy. Except once, in Poland, during World War II, when a pair of quick-thinking doctors used a little-known, harmless organism to defend their people from the Nazis.

The microorganism was Proteus OX19. In most ways it's an entirely ordinary little bacterium. Its one remarkable feature is that human antibodies for Proteus OX19 cross-react with the antibodies for rickettsia—the bacterium responsible for the deadly disease typhus. The most common screening method for typhus, the Weil-Felix test, uses this cross-reaction as part of its detection, and therefore the Weil-Felix test cannot distinguish between a patient with typhus and one with a proteus infection.

Typhus is an insect-borne disease, spread by body lice and other insects that bite their human hosts. The bite does not transfer the bacteria—it is generally concentrated in the insect's feces. When the irritated human scratches at bites, he also inadvertently rubs the contagion into his skin. Through human history, typhus has been responsible for devastating epidemics—most often following in the footsteps of wars and famines. Characterized by headaches, high fever, cough, rash, and delirium, it is both highly contagious and deadly. A typhus outbreak between 1577 and 1579 is believed to have killed 10 percent of the English population. During World War II, typhus outbreaks were common in German concentration camps. Camp Bergen-Belsen was particularly notorious for its typhus outbreaks. Anne Frank and her sister Margot died of typhus there in 1945. The spread of the disease within the army was always a concern.

Two physicians, doctors Lazowski and Watulewicz, were living in Poland when the Nazis invaded in 1939. Not long after establishing an occupation, the Germans began deporting the Polish population into concentration camps. One young man, condemned to slave labor in Germany, appealed to the two doctors for help, and they devised a unique deception. They injected him with Proteus OX19 and then sent a blood sample back to Germany for testing. As expected, the Weil-Felix test came back positive for typhus, and the young man was ordered to remain in Poland.

Encouraged by this success, the good doctors went on to try the same deception on a larger scale, sending in Proteus-infected blood samples from some dozen small villages. Germany was rightfully alarmed at the idea of typhus spreading through their ranks. An epidemic originating in a camp could easily spread into the general German population. Nazi officials started requesting broader blood tests, and they sent a medical team into the "afflicted" areas of Poland. The Polish doctors continued to inject a number of other people with Proteus to induce false positives, but an on-site Nazi medical team could well have proved their undoing. So the doctors devised a further deception—one dependent on hard liquor and the German fear of typhus contagion. From the *British Medical Journal*:

“A Nazi deputation consisting of an elderly doctor and two younger assistants was sent to investigate the results sent by Drs. Watulewicz and Lazowski. They were cordially received in the traditional Polish manner, and given food and vodka. The senior doctor did not personally inspect any of the village, but remained to be entertained, dispatching his juniors. They made a cursory examination of the buildings but, being aware of the risks of infection, were easily dissuaded from closer inspection. An old man dying of pneumonia was brought in for the senior doctor and with much drama shown to be severely ill with, it was claimed, typhus fever. As Goethe said, ‘We see what we know.’ They saw, were convinced and left.”

With the medical team now convinced, the Nazis quarantined several towns and villages in an attempt to avoid the dangerous “infection,” thus sparing the residents the ravages that killed a fifth of Poland’s population by the end of the war. The purposeful infection of innocent people was a tremendous triumph for the Polish doctors and the people they helped. Whether they realized it or not, their inventive tactic was unique in the annals of biological warfare.

PROJECT PLUTO

A weapon so devastating that even its most ardent advocates balked

In the mid-1950s, the politics of the Cold War demanded that the United States be able to obliterate the population of the USSR faster and more thoroughly than the enemy could do in turn. America's arsenal didn't seem up to the task: Bombers were slow and easily detected, while intercontinental ballistic missiles (ICBMs) were still undergoing a rocky adolescence. The minds at the Pentagon concluded that something more was needed. The result of their nefarious brainstorming was Project Pluto, a weapon so terrible that its own greatest proponents would balk at it before the end.

The goal of Project Pluto was the development of a new Supersonic Low-Altitude Missile, or SLAM—a missile that could fly below enemy radar at three times the speed of sound. What made this weapon revolutionary was its unique propulsion system. SLAM was designed to use a ramjet—a simple type of jet engine that "rams" air through its intake by its own forward momentum, then heats the air and ejects it through a rear nozzle to provide thrust. Inside the Pluto's unique engine, the necessary heat would be provided by a 500-megawatt onboard nuclear reactor.

This nuclear-powered engine would give SLAM some unheard-of capabilities. Unlike a conventional cruise missile, which delivers a single explosive upon impact, Pluto was designed to drop multiple bombs on a spread of targets. Its atomic power source would give it enough range to fly about four



■ NASA's X-43A scramjet, a non-nuclear descendant of SLAM technology.

and a half times around the earth, enabling a single missile to zigzag across a continent ejecting hydrogen bombs—up to 26 of them—on anything deemed worthy of destruction. The explosives would be lobbed from chambers in the top of the missile with an arced trajectory to give SLAM enough time to escape the blasts.

Nuclear bombs were only the beginning of the havoc SLAM would wreak. The sonic boom of a yacht-sized craft flying at such speeds and low altitude would be enough to sow a maelstrom upon the structures and people beneath it. Along the way the missile would roast the landscape with gamma and neutron radiation from its unshielded reactor, spitting fission fragments out through the exhaust to conveniently contaminate swaths of the enemy landscape. When its mission was complete, SLAM would crash itself into one last objective, smearing its "hot" reactor across the target of choice to produce a violent radioactive meltdown.

Development on Project Pluto officially began on January 1, 1957, at the Lawrence Livermore National Laboratory in California. From the start it was clear that it would be a challenge. The low altitude and high speed of the weapon meant that the craft's components would have to endure aerodynamic forces five times greater than those in other missiles, all while seated next to a 2,500-degree nuclear reactor. SLAM had to be exceptionally rugged, but still light enough to fly. This sturdiness combined with its straightforward ramjet design earned SLAM the nickname "the flying crowbar."

The level of automation built into SLAM would also be a major advancement. With its ability to autonomously strike multiple targets, SLAM was less a cruise missile than an unmanned long-range bomber. Guidance was to be accomplished through a Terrain Contour Matching (TERCOM) system, which would automatically compare real-time radar data against onboard terrain contour maps. The missile would thus know its precise position at all times and could adjust to the terrain to hug the ground as it flew. The navigation system was a concept ahead of its time—as a comparable system wouldn't make it into a cruise missile until the 1970s.

By 1961, Livermore had a prototype engine ready for testing. The nuclear ramjet, code-named "Tory," was shipped to a specially constructed eight-square-

mile facility in the middle of the Nevada desert's Jackass Flats. There, 25 miles of oil-well casing were packed with the million pounds of compressed air needed to simulate flight conditions.

Driven by its nearly unlimited nuclear fuel source, it could roar across America's most populous landscapes, killing and contaminating everything beneath it.

On May 14, 1961, from a safe distance atop an emergency fallout shelter, the team behind Project Pluto watched as their Tory-IIA nuclear jet engine came alive for the first time. Mounted on a flatbed rail car, the ramjet ran for only a few seconds, but without even a hint of apocalyptic catastrophe. The test was a complete success.

The team quickly moved onto development of a lighter, more powerful engine, and three years later, in spring of 1964, the Tory-IIC was rolled out onto the same testing ground. When the switch was flipped, the engine sang at 150 decibels, outputting 513 megawatts and more than 35,000 pounds of thrust—this time for five uninterrupted minutes. A crowd of onlooking Atomic Energy Commission and military officials applauded the spectacular display of power, while members of the Livermore team spoke excitedly of how it would take only a few tweaks to make the Tory-IIC airworthy. It seemed that SLAM's first flight was imminent.

Fortunately, it was not to be. The tactical landscape had changed over the previous seven years; development of ICBMs was coming along faster than expected, and, at speeds in excess of Mach 15, they made SLAM seem positively plodding by comparison. The \$50 million price tag on each Pluto

missile (\$350 million in today's dollars) was beginning to sound like less of a bargain.

Perhaps a few fragments of sanity had somehow infected the project's sponsors at the Pentagon. Awkward questions began to be raised about the wake of radioactive devastation emitted by the SLAM engine, a trait that had once been viewed as a military asset. Although SLAM was intended to be launched from American soil by conventional booster rockets, its deadly nuclear ramjet would have to cross some amount of allied land en route to its targets in the Soviet Union.

Of more immediate concern was the issue of how the flight-ready SLAM could be tested. If the missile went out of control—and there was a reasonable chance that it might—there would be no stopping it. Driven by its nearly unlimited nuclear fuel source, it could roar across America's most populous landscapes, killing and contaminating everything beneath it. Even a perfect test flight wouldn't solve the problem of what to do with the highly radioactive airborne mis-

sile when it was over, and proposals to crash it into the ocean were met with considerable resistance. Pluto's former advocates began to feel decidedly uneasy about their monstrous offspring.

On July 1, 1964, Project Pluto was officially scrapped. The Supersonic Low-Altitude Missile would never be completed, though its numerous innovations in materials science and reactor engineering provided a lasting legacy. Pluto also left behind a slightly wiser team of 450 scientists, engineers, and technicians at the Livermore Laboratory, who would go on to work on comparatively wholesome projects such as developing plain-vanilla thermonuclear warheads.

SLAM—and its promise to utterly annihilate one's enemies—still has a place in some defense officials' hearts, so superweapons such as Project Pluto remain ever on the brink of possibility. But for now, at least, the world remains safe from the flying crowbar of doom.



■ A new generation of ICBMs, including this Titan, made the Pluto seem plodding.

THE REVELATIONS OF RESTORED SIGHT

For some, the gift of restored sight can be a curse

“Suppose a man born blind, and now adult, and taught by his touch to distinguish between a cube and a sphere of the same metal. Suppose then the cube and sphere were placed on a table, and the blind man made to see: query, whether by his sight, before he touched them, could he . . . tell which was the globe and which the cube?”²⁹



his question was posed by Irish philosopher William Molyneux in a letter to his English contemporary John Locke in the late 17th century, and has come to be known as Molyneux's Problem.

Locke believed that since touch and sight are so divergent, they must not overlap, and thus his answer to Molyneux's conundrum was “no.” Later philosophers and psychologists tended to agree. However, Molyneux's thought-experiment is no longer wholly hypothetical; there have been striking case studies, such as that of Sidney Bradford, an Englishman who at the age of 52 was operated upon twice to remove cataracts in both eyes that had rendered him almost entirely blind before he was a year old. British psychologist Richard Gregory became aware of Bradford between his two cataract operations and was able to extensively study the patient's progress exploring vision for the first time in his adult life.

His findings were not only very compelling in their own right, but helped to show that what psychologists call “cross-modal transfer”—information gained through one sense being applied through

another—is not as inconceivable as earlier scholars had concluded. In spite of impressive progress learning to process visual input for the first time, though, Sidney Bradford's life quickly turned toward profound tragedy.

Born in England in 1906, Bradford developed cataracts in both corneas by the age of ten months. Technically his condition was best classified as near-blindness, since his retinas were intact; he could perceive light in his left eye and very limited motion close to his right one. Nevertheless, Gregory inferred from Bradford's family and school records that even as a small child it was unlikely

he had enough vision to identify anything on site—Bradford himself reported that he had only the faintest of visual memories from his first few months of life: the colors red, white, and black.



■ William Molyneux, poser of his eponymous problem.

Though his family was not very well off, he was educated quite thoroughly at a residential school for the blind in the city of Birmingham. At the school he learned to read and write Braille, and was taught a number of crafts that could be performed without vision. As with many of the sight-impaired, he learned to rely on echoes to help orient himself to nearby objects and surfaces. He was eventually employed as a mechanic, and took a substantial amount of pride in the fact that he was able to live independently despite being unable to see. He married, kept a vegetable garden, and once painted the exterior of his house by feeling alone. He had even ridden a bicycle, albeit with a friend's hand on his shoulder to guide him throughout.

For decades, doctors had believed that Bradford's lack of sight could not be corrected by surgery. However, in 1958, surgeon A. Hirtenstein examined Bradford and found himself disagreeing. Bradford's retinal vessels were normal, the cataracts were confined to his corneas, and his ability to move his eyes was found to be normal—an ability uncommon in a near-blind person that was possibly as a result of having normal vision for a very limited amount of time in infancy. Therefore, Hirtenstein was convinced that giving Bradford his vision back would require no more than a corneal transplant in each eye. The operations were performed just under a month apart, in December 1958 and January 1959.

Gregory learned about Bradford through his research assistant, Jean Wallace, and the two met only days after the first eye was operated upon. The subject struck the psychologist as bright, sociable, straightforward, and self-assured. Bradford had a marked distaste for being surprised, but was generally very pleasant company.



■ Professor Richard Gregory is a neuropsychologist with a focus on human perception.

Just as Hirtenstein had been, Gregory was astonished by Bradford's ability to use his newly regained vision. Shortly after the surgeries were completed, they began formal testing of Bradford's sight. The subject was able to identify many objects in the room, as well as cars and trucks out the window. His color vision was virtually normal. He also proved himself able to read the time off a large analog clock. He brought out a pocket-watch and explained that he had always told time by touching the hands with his fingers, though whether this was a true case of cross-modal transfer is unclear, since it had been some time since Bradford's operations and he could have learned to recognize the visual form of the clock by then. He was very capable of recognizing the sizes of objects and rooms that were familiar to him by touch. Only things that he had never had the opportunity

to touch were surprising in their appearance—the moon, for example.

Bradford was captivated by the sight of cars and trucks, and was observed to get up early in the morning for the express purpose of watching them from his window. This probably had something to do with his work with automobiles before his operation. Reflections—something entirely novel to him—were a major source of interest as well.

Faces were the biggest challenge for Bradford; he did not recognize expressions, and felt no need to learn to do so.

The most fascinating revelation was that Bradford was spontaneously able to read the title of a magazine, *Everybody's*. When the astonished psychologists asked how he had been able to do so, Bradford admitted that he had only truly read the first two letters and guessed that the rest of it corresponded to the magazine's title, which he had previously heard. However, this was no less impressive. As it turned out, Bradford had learned the uppercase written alphabet in school by *feeling* the shapes of the letters. That he was able to recognize an E and a V visually now was strong evidence for cross-modal transfer. Later he was able to do the same thing with every single number-shape on a series of cards normally used to test color vision.

Of course, there were difficulties. Faces were the biggest challenge for Bradford; he did not recog-

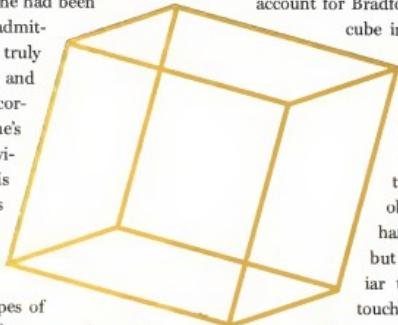
nize expressions, and felt no need to learn to do so. Furthermore, the only reason that he knew what faces were in the first place was that voices came from them. He said he never recognized people by their faces but by what they sounded like and sometimes what they were wearing. His vertical depth perception from above was skewed as well; Bradford greatly underestimated the distance from his hospital room to the ground. Later on, looking up at the same window, he became aware of his miscalculation.

Intriguingly, Bradford was just about immune to most of the deceptions of optical illusions; when Gregory presented them to him, he was able to describe them without being fooled. For instance, he perceived the famous Necker cube as a flat hexagonal figure without any resemblance to a cube at all, let alone two pseudo-three-dimensional cubes of alternating perspective. This is a significant finding, since it suggests that the perception of optical illusions is learned. If one can only see the two perspectives of the Necker cube with practice, it would account for Bradford's inability to observe a cube in the drawing even when trying to do so.

Bradford's ability to draw provided additional fascinating results over time. His initial pictures—sketches of simple objects such as houses and hammers—were recognizable but included only details familiar to Bradford from having touched them or walked on them.

Gregory proposed that although he had become good at naming objects he was looking at, he was having trouble calling up visual memory

■ *The ability to see many optical illusions, including the one in this Necker cube, is learned, rather than inherent.*



in order to draw from it. Over the course of the next year, however, Bradford was asked three times to draw a bus. Each resulting drawing was considerably more accurate than the previous one, showing that he was clearly starting to integrate new visual information into his mental depictions of objects, though there were still omissions for parts he had never touched, such as the front of the bus.

Despite all of his progress, Bradford was having other difficulties. His overall confidence fell noticeably; for example, he was having much more trouble crossing the street now than he had *before* the operations on his eyes. Venturing outside began to frighten him, which was unprecedented; even when accompanied by a trusted person, he became uncharacteristically timid and withdrawn. A visit to a science museum piqued his interest briefly, but he derived more pleasure from running his hands over the tools with his eyes closed than from looking at them. Molyneux and Locke's answer to the infamous question ended up having some validity after all; Bradford did not feel that he had properly examined the tools until he had touched them thoroughly. Meanwhile, the fact that he could not read text made him self-conscious. Reflections and observing changes in perspective were interesting

and entertaining to him, but Bradford's satisfaction with life still decreased dramatically.

Gregory suggested later that the pride Bradford had taken in being self-sufficient despite his disability had now been undermined by the difficulties he was having with sight. The psychologist wrote, "[Bradford] suffered one of the greatest handicaps, and yet he lived with energy and enthusiasm. When his handicap was apparently swept away, as by a miracle, he lost his peace and his self-respect."

This sort of psychological decline had been observed in several earlier cases of vision acquired later in life and ended up affecting this subject to an extreme degree. After a prolonged period of ill health, Sidney Bradford passed away on August 2, 1960 at the age of 54. Although Gregory's report on the case does not specify the cause of death, some sources indicate that he took his own life. Despite the deeply sad repercussions of Sidney Bradford's reintroduction to the visual world, his experiences were recorded in enough detail to provide crucial insights into human visual perception and its development. His experience also serves as a stark reminder that restored vision is not necessarily the unqualified miracle that popular opinion has often considered it to be.



SECRET AGENT CANDY JONES

A troubled former pinup girl claims to lead a double life as a CIA operative

Jessica Wilcox was born on New Year's Eve in 1925. Her father left the family when she was just three years old, and her mother was a critical and cold caretaker. The young girl was often left alone for hours in a darkened room, with only imaginary friends to help her pass the time. Jessica's best imaginary friend was "Arlene," a pretend person who grew up with her despite striking personality differences: Jessica was open and articulate, Arlene was cynical and contemptuous like her mother. The other imaginary friends faded, but Jessica never grew out of Arlene—rather Arlene grew into Jessica and became a separate personality.

At age 16, Jessica won the Miss Atlantic City contest. Her long blonde hair, shapely features, legs-up-to-here, and ample bosoms garnered her considerable attention from the media, particularly when she applied her feminine wiles to hosting the Miss America Contest later that year. Amidst the dramatic music and storm of flashbulbs, Jessica Wilcox became a star. As the pageant drew to a close, John Powers of the infamous Powers Modeling Agency approached her and made an offer she couldn't refuse: to move to New York City and work for his agency. This turn of events ultimately led to Jessica's fame and a new name: Candy Jones.

During World War II, Candy was one of the world's most popular pinup girls. She dressed in trademark red-and-white candy-striped outfits made of surprisingly little fabric, and toured with the USO through the South Pacific in 1944 and 1945. While on tour in April 1945, Candy



Candy Jones celebrates V-J day with the troops.

became very ill with malaria and was taken to a hospital in the Philippines. While there she befriended a medic whose real name has been obscured over time, but is known by the pseudonym of "Gilbert Jensen."

After the war, Candy went home and married, then divorced. She opened a modeling school. She took to writing, and had five books on modeling and fashion published over the years. She was getting along pretty well when she was approached in 1960 by an FBI agent—an old acquaintance from her USO days—who asked her for her help. It seemed a benign request, and it was only patriotic to help out; so she allowed him to use her office on 52 Vanderbilt Avenue as a secretive government mail drop.

She was taught the subtle art of killing with her bare hands or, if handy, a hat pin.

And that was the entire story until 1972, when Candy married John Nebel. The pair had a true whirlwind romance, having known each other only a month before they married. After they wed, Nebel started noticing Candy displaying huge, sudden mood-swings, the worst of which was when she'd slip into what he described as "the Voice"; in his own words as "a look, a few moments of bitchiness." A few weeks into the marriage Candy told her new groom that she sometimes worked for the FBI and that she would be prone to vanishing for days on end without notice. Slowly Nebel discovered that Candy was also suffering insomnia, and in a desperate gambit to improve her moods, he offered to hypnotize her to help her sleep.

Nebel hadn't hypnotized anyone before, and Candy was resolute that it couldn't be done. It apparently worked, however, and she fell into a more restful sleep than she'd had in years. They

decided to continue the sessions. As the hypnosis continued, Nebel learned that Candy became unusually susceptible to suggestion while under, and more disturbingly, she would spontaneously age-regress and speak in a childlike voice—sometimes her own, and sometimes Arlene Grant's. It was this behavior that spooked Nebel into tape-recording the sessions.

In talking with the hypnotized Candy, Nebel uncovered a plot that had roots in a 1945 Philippine hospital and began in earnest when the FBI had asked for her help years later. Candy had only a few memories of the things she was asked to do, but her alter-ego Arlene had a detailed knowledge of all of them. While her modeling school was doubling as a government mail drop, she was asked to drop a letter in Oakland, California. When she arrived, doctor Gilbert Jensen from the Philippines awaited her. He offered her a tidy sum of money to allow him to hypnotize her, and she accepted, since she was divorced and strapped for cash. He told her later that the hypnosis hadn't worked, but Arlene informed Nebel that it actually had.

According to Candy's claims under hypnosis, Jensen asked her to be a messenger for the CIA, and told her that her post was to be so secret that not even headquarters would know about her. In order to serve, she needed to be in top health, and thus submitted to regular injections of vitamins. These were, of course, not vitamins, but a chemical agent designed to bring out the Arlene persona. When she assumed the Arlene identity, she would alter her dress, her walk, and her tone—she even took to wearing a dark wig. Arlene was supposedly sent to training camps where she was taught the subtle art of killing with her bare hands or, if handy, a hat pin. She was trained to use poison lipstick, to hide code numbers under her nail polish, and other James Bond-ish contraptions. She was told that she would be asked to run government drops on her normal business trips, and that it would be ideal if Candy had no recollection of performing these tasks.

But was any of it real, or was it False Memory Syndrome brought about by a truly disturbed woman and an inept therapist? While the latter is the more sensible explanation, there are some provocative hints that point to the credibility of her story.



■ Candy Jones, or perhaps Arlene Grant, shows off her modeling skills.

In the 1960s Candy told her book editors that she sometimes worked for the FBI. Candy also wrote a letter to her attorney instructing him that if she were to die or vanish that he wasn't at liberty to reveal the details of the event to anyone. In 1974 the Rockefeller Commission exposed CIA's MKULTRA

Program—a mind-control program that was going on in the 1950s. Several times she was absent from her modeling school, or on business trips where there was no business to do. When author Donald Bain approached her about publishing a book on the story of her life, she produced a passport she'd found in the name of "Arlene Grant" bearing a photo of her in a dark wig and makeup.

One source cites a tape from the answering machine at Candy's house. It contains a recording of a message received July 3, 1973: "This is Japan Airlines calling on oh-three July at 4:10 P.M.... Please have Miss Grant call 759-9100... she is holding a reservation on Japan Airlines Flight 5, for the sixth of July, Kennedy to Tokyo, with an option on to Taipai. This is per Cynthia that we are calling." When Candy called Japan Airlines back, there was no Cynthia working there.

Jones's claims and circumstantial evidence were made public in 1974 with the publication of the book *The Control of Candy Jones* by Donald Bain. None of it is proof. Nor is the fact that in July 1980 Candy was nearly killed in an explosion. It's all just hints, innuendo, ticklers of possibility. She later died, but not due to a poison dart or mysterious midnight garroting; she succumbed to cancer in 1990.

Some of Candy Jones's critics point out that investigating outlandish claims from a troubled mind is a fool's errand. One cannot help but wonder whether the CIA is truly so imprudent that they would recruit a superconspicuous 6'4" supermodel as a supersecret agent. Perhaps not; but then again, the CIA has been found guilty of much grander foolishness on many occasions.



SIDIS'S SUPERBRAIN

A young prodigy becomes his parents' pet project—with unexpected results

In the waning years of the 19th century, boatloads of Russian Jewish immigrants were arriving in New York harbor as they fled from the religious and political persecution of their homeland. Boris and Sarah Sidis arrived in such a fashion, but they quickly stood out from the crowd, gaining notoriety in the United States as brilliant individuals. Boris established a reputation for himself as a pioneer in the study of psychology, and his wife became one of only a handful of women in America to receive a medical degree. Though they were widely regarded as the possessors of highly gifted minds, they were also renowned for their eccentricities.

After breezing through Harvard as a student, Boris became a professor of psychology there, where he taught and wrote about his groundbreaking theories in the field. He was influential in the areas of hypnosis, group psychology, and mob frenzy, and he was fascinated with the effects of evolution on the human psyche. He was also an advocate of some bizarre treatments such as the "rest cure," whereby victims of mental disorders were isolated in bed for up to two months, sometimes in tandem with electrotherapy. Much of Boris's work was experimental and adventurous in a time when the field of psychology was making great strides.

On April Fool's day in 1898, Boris encountered a unique opportunity to begin applying his eccentric theories of psychology in a real-world environment: Sarah gave birth to a son. Under the tutelage of these ingenious yet neurotic parents, young William James Sidis developed into an individual with astonishing talents.

Boris and Sarah began their child's education in his first few months, and William's infant mind absorbed the information at an extraordinary rate. Using wooden blocks, Boris began demonstrating the alphabet to his young son, applying techniques similar to hypnosis to coax the baby into pronouncing the letters. At six months, William uttered the word "door," and by the following month he had doubled his vocabulary to include "moon." When he was eight months old, his proud parents boasted that he was able to feed himself with a spoon, a skill that very few children develop within their first year. He was also able to recognize and repeat the letters on Boris's toy blocks, giving him a four-year-old's grasp of symbol recognition.

The Sidises believed that aggressive curiosity was a quality to be nurtured, so Sarah gave up her career in medicine to dedicate her life to the child's development. William's thirst for knowledge never went unquenched, and by his first birthday—an age

when most children are still babbling—he was honing his spelling skills. At one and a half years of age, he was reading the daily newspaper.

As William approached his fifth birthday, his spectacular abilities began to draw the attention of the press. He had taught himself to operate the typewriter from his high chair, tapping out a letter to Macy's regarding an order for toys. He had also taken it upon himself to learn Latin, Greek, Russian, French, German, and Hebrew. His appetite for information seemed endless as he chewed easily through weighty tomes such as *Gray's Anatomy* and the works of Homer. He entered grammar school at age six, but in just over half a year he had advanced into high school curriculum. His stunning accomplishments soon became a frequent feature on the first page of *The New York Times*.

Boris and Sarah were understandably proud of their son and his intellectual achievements. By cultivating his precocious nature, it seemed that they had confirmed some of their outlandish theories, and they paraded young William around as evidence of this. But the question of how much was due to their influence and how much was due to his own natural genius is a matter of some debate. Their approach may have contributed to his development, but it is clear that his mind had a natural propensity for gorging itself on information.

At age nine William attempted to enroll at Harvard, and though the entrance exams were not

a challenge for the young intellect, he was turned down on the basis that he was too "emotionally immature" for college life. As William waited for the Harvard admissions board to capitulate, he spent the intervening time at Tufts College correcting mistakes in mathematicians' books, perusing Einstein's theories for possible errors, mastering foreign languages, and diligently collecting streetcar transfer

slips. He discovered that he could mentally calculate the day of the week for any given date in the past or the future, and he wrote four books. When the boy prodigy reached 11 years of age in 1909, Harvard finally relented and accepted William as a student.

On a cold January evening in 1910, about a hundred professors and advanced math students gathered in a Harvard lecture hall to observe 11-year-old William Sidis's first public-speaking presentation. He spoke in a quiet, shy voice and had to stifle the occasional giggle, but his lecture on four-dimensional bodies

was very well received. It was sufficiently advanced that it bewildered many of his audience members, as indicated by the depth of his introduction:

"My own definition of the Fourth Dimension would be that it is an Euclidian space with one dimension added. It is the projection of the figures of the Third Dimension into space. The third dimensional figures, such as the cube, are used as sides of the figures of the Fourth Dimension,



■ William James Sidis at age 17.

and the figures of the Fourth Dimension are called configurations. It is not possible to actually construct models of the figures of the Fourth Dimension, or to conceive of them in the mind's eye, but it is easy to construct them by means of Euclid's theorem.

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After William's presentation, MIT professor Daniel Comstock predicted to reporters that Sidis would become the foremost mathematician of the 20th century. The story of William's exploits shortly became national news.

Sidis graduated cum laude at age 16, having grown a bit introverted in response to the sudden fame and pressure. At his graduation, he told the gathered newspapermen, "I want to live the perfect life. The only way to live the perfect life is to live it in seclusion. I have always hated crowds." He began a lifelong policy of vigorously rejecting sex, art, music, or anything else that would distract him from the pursuit of pure knowledge.

William taught mathematics briefly at Rice University in Houston, but he resigned when it became apparent that his age and fame were incapable distractions to the students. He went back to Harvard for a short time to pursue a law degree, but dropped out when he found that the law did not suit him. In 1919 William was once again subjected to public scrutiny when he was arrested for participating in an antidraft demonstration that developed into a riot. The ensuing trial further underscored his unconventional philosophies, such as his lack of a belief in God—particularly the "big boss of the Christians"—and his socialist leanings. His political views later evolved into something resembling Libertarianism.

He sidestepped imprisonment thanks to his parents' influence, but they confined him to their summer home in California for a year after the event. Embittered, William moved back to the East Coast in an effort to retreat from the press, his parents, and his talents—all of which he regarded as blights.

He took up a series of menial jobs working as a clerk and a bookkeeper, moving to a new employer whenever his identity was discovered. "The very sight of a mathematical formula makes me physically ill," he once said. "All I want to do is run an adding machine, but they won't let me alone." On one occasion Eastern Massachusetts Street Railway Company hired him and handed him a stack of blueprints and statistics in the hopes that he could improve their system; he was reduced to tears at the prospect of the computations, and quit the new job on his first day.

He had taught himself to operate the typewriter from his high chair.

Sidis made a noble effort to avoid the public eye in his adult years. He wrote several books, but most of them were under assumed names and about obscure subjects. One such book, entitled *Notes on the Collection of Streetcar Transfers*, discusses his unusual hobby of *peridromophilia* at painstaking length. The work was described by one Sidis biographer as "the most boring book ever written." William also alluded to the existence of dark matter before it had been formally theorized, and wrote about how one democratic Native American tribe may have strongly influenced the politics of America's founders. In the meantime he continued to learn new languages, absorbing dozens of foreign tongues with ease.

The press continued to hound William for years, poking fun at his humdrum jobs and scorning his neglected potential. One *New Yorker* article entitled "April Fool" was so scathing and filled with personal details that it prompted Sidis to sue for invasion of privacy, a case that went all the way to the U.S. Supreme Court. He finally won a partial victory in 1944, but it was a bittersweet success.

INSIDE THE MIND OF A GENIUS

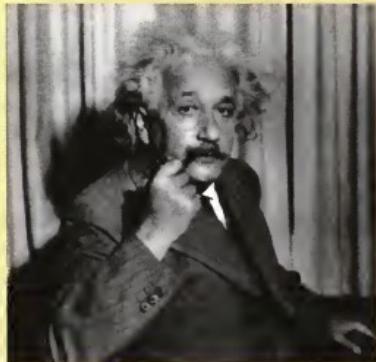
When Albert Einstein died in 1955, the inspection of his brain offered some clues about the physical configuration of the genius mind. His remains were cremated without ceremony in accordance with his wishes, and his ashes were scattered in an undisclosed location.

But his mighty brain was spared the crematorium.

Pathologist Dr. Thomas Harvey, who performed the autopsy, kept the pilfered brain in 240 sections stored in formaldehyde jars in his home. He eventually lent samples to Dr. Marian Diamond at UC Berkeley. She discovered that Einstein's brain contained about 73 percent more glial cells, suggesting that his neurons required and used far more energy than the average man who died at his age.

In 1996 Harvey relinquished the remaining pieces to the chief pathologist at Princeton Hospital where other scientist discovered the brain was 15 percent wider than average as a result of highly developed inferior parietal regions providing powerful visualization skills, visuospatial cognition, and mathematical thought.

Today the pieces remain in their formaldehyde jars at Princeton Hospital, one of many lasting relics from a man who once remarked, "I have no special talents, I am only passionately curious."



William did not live long after that; the following July his landlady telephoned the police after discovering him unconscious in his Boston apartment. Forty-six-year-old Sidis had suffered a massive stroke, and he never again regained consciousness. Such was the end of the one-time prodigy who had astonished a Harvard math audience at age 11. He died a reclusive, penniless office clerk.

Those who knew him later in his life spoke of his conspicuous brilliance and his mastery of over 40 languages, but his tangible contributions to society seemed to be relatively few for someone of his talents. Some argue that his parents pushed him

too hard in his youth—overexerting his exceptional mind at an early age—and some blame the press for driving him into isolation.

Though he probably would not have put much stock in formal measures of intelligence, it is estimated that William Sidis's IQ was as high as 300, where 100 is average and over 140 considered genius. Whatever the reason for his underwhelming output later in life, he was certainly one of the most profoundly gifted human beings who ever lived. There is no telling what William might have accomplished in mathematics and science if only his talents had not been squandered.

THE SKYHOOK

Catch a flight—without landing

During the Cold War, the U.S. and the Soviets had an ongoing game of tag taking place above and below the arctic ice. Both sides installed electronically-equipped shanties under the guise of “research stations” on the arctic ice floes, and while there was a potential for real science to take place in such locales, the actual purpose of these corrugated steel huts was to house hydrophones that would eavesdrop on the submarines wandering through the Arctic Sea. An unusual difficulty arose, however, in manning these stations: They were beyond the limited range of the period’s helicopters, too far into the floe for icebreakers, and in areas that were not merely inhospitable but downright hostile to the landing of airplanes.

The process of deploying personnel wasn’t too daunting. It was merely a matter of throwing a soldier from an airplane without stopping—anyone who pulled arctic-listening-post duty had to parachute onto the ice. When it came time to bring them back home, their extraction was very much like their dramatic parachute entrance, only in reverse.

After the initial snap of being pulled from the ground, he rose slowly into the air until he was trailing behind the aircraft at jowl-flapping speed.

The idea of fly-by retrievals was first explored during World War II. American and British soldiers would equip with a full harness and connect it to a long loop of cable strung between two tall poles. A spe-

cially fitted aircraft (usually a C-47 Skytrain) swooped in low and hooked the length of cable between the two poles, thus lifting the soldier from the ground. Though the system worked, it was generally cumbersome and took a long time to set up.

Experiments for an improved system began in 1950 under Robert Edison Fulton Jr., an inventor for the CIA. His goal was to pick up a weight from the ground using an easier method than the twin-pole technique employed in the war. He tested his various ideas, and by 1958 Fulton had developed a reliable system.

The Fulton Surface-to-Air Recovery System, more commonly called the “Skyhook,” was a package that could be dropped from a plane to any target, where a single operative with proper training could outfit a person or package for pickup. The kit consisted of a harness; a length of high-strength nylon line; a portable helium bottle; and a dirigible-shaped balloon. All it lacked was the courage that a person would need to use it. The intended target would climb into the harness and connect it

to the balloon with the nylon wire. With the simple pull of a ripcord, the helium bottle would inflate the balloon, sending the line, which was marked with a bright flag or light, up to await the plane.

The pickup plane was fitted with a pair of tubular horns on the nose. During a retrieval, the pilot aimed toward a marker on the line, which ensured that the horns would then catch it. A mechanism would snap closed when the line was caught, releasing the balloon and anchoring the line to the aircraft. As the target was lifted from the ground, the line streamed back into the aircraft's wake. The plane's crew would use a long hook to catch the line, and the new passenger would then be winched into the bay.

A series of tests were run using instrumented dummies that recorded the jolts and pressures they received. After a successful run in which none of the crash-test dummies were dismembered, the first live test was scheduled for summer 1958. The test was conducted with a pig as the target. The hog was harnessed and hooked to the balloon, where it waited only a short time before being snagged. Due to some stability issues, the pig spun in the 125 mph wind beneath the plane and arrived on board dizzy and discombobulated. It recovered, however, and promptly attacked the crew.

Later in 1958, Staff Sergeant Levi W. Woods became the first human to experience the Skyhook system. After the initial snap of being pulled from the ground, he rose slowly into the air until he was trailing behind the aircraft at jowl-flapping speed. During the ascent he extended his arms and legs, thereby thwarting the oscillations that had plagued the pig. Six minutes after the process began, Woods was safely aboard the P2V *Neptune*. There were no reports of hostility toward the crew. Following this successful test, the Skyhook was approved for military use. In 1961 the Skyhook was assigned its first mission: Operation Coldfeet.

■ *A test subject takes the Skyhook for a ride.*



DEVELOPING TECHNOLOGY

Skyhook technology proved invaluable to the United States Air Force as it developed some of the world's first spy satellites. It was particularly useful in a program code-named Corona in which the USAF launched a series of covert surveillance satellites under the guise of a basic space-technology study. Throughout the 1960s, these high-resolution orbiting cameras discreetly snapped hundreds of thousands of photos of Soviet installations, with specific emphasis on the facilities producing long-range bombers and ballistic missiles.

Because these pioneering spacecraft predated digital imagery, each panoramic camera stored its photos on a roll of black-and-white or infrared film. Once the onboard film was used up, a Corona satellite would reach the climax of its mission by ejecting its film canister into the Earth's atmosphere. A USAF aircraft would then fly by and retrieve the film from midair as the package descended toward the ocean on a tiny parachute. The film canisters were also designed to float in case the aircraft missed its rendezvous.

The U.S. desperately wanted to take a peek at the Soviets' toys, and as luck would have it, the Soviets abandoned one of their floe stations in March 1962. A crack in the ice had destroyed the runway of station NP8, rendering it unreachable to Soviet aircraft. In June, two U.S. spies were loaded onto an airplane and flown to the remote arctic region, where they parachuted onto the ice. After they gathered the intelligence, their pickup was a little tricky. The weather had degraded to nearly white-out conditions, and the surface winds were near 30 knots. The first pickup went well, but when the balloon was launched for the second retrieval, it immediately caught in the wind. The hapless agent was dragged unceremoniously across the ice. As he tried to regain his breath, the plane hooked the line. He swung wildly in the void, unable to see and whipped by the cold wind. To the credit of the Skyhook's design, he managed to orient himself, and was pulled safely aboard. Despite

the adversarial weather, everyone came back safely and the intelligence they gathered was very useful. With this supreme accolade, the Office of Naval Research approved the Skyhook for general use.

The Skyhook was used on multiple occasions during its 35 years of service, resulting in only one fatality despite the apparent high risk involved in such fly-by pickups. The system was eventually rendered obsolete with the arrival of longer-range helicopters that could execute remote pickups with less bustle. In 1996, the U.S. military ceased maintaining the Skyhook program, much to the chagrin of thrill seekers everywhere.

Although there is presently no active Skyhook training, the straightforward system still offers certain advantages where high-speed extraction is necessary and hovering helicopters are impractical. When that day comes, the Fulton Surface to Air Recovery System will still be there, ready to rise to the occasion.

SPIES ON THE ROOF OF THE WORLD

Citizen-spies are sent to peaks of the Himalayas with a nuclear package

On October 16, 1964, a great mushroom cloud towered over the remote missile-testing range at Lop Nur in western China. Prior to this sobering event, CIA analysts had surmised that Chinese scientists had been at least a year away from squeezing the destructive secrets from the mighty atom. The news of this bombshell underscored the agency's dangerously feeble intelligence regarding the Far East.

The U.S. regarded the 22-kiloton development as an unwelcome wrinkle in the already precarious Cold War. Officials from India were also distressed, having felt the business end of China's military during a recent border dispute. In the interest of self-preservation, the two nations made a secret pact to combine their China-watching efforts. Photo reconnaissance satellites were still too primitive for practical spying and high-flying surveillance planes were too conspicuous, but there was one alternative vantage point. The intelligence agencies hatched a nefarious scheme to keep an eye on China's weapons tests from atop India's Nanda Devi, one of the tallest mountains of the Himalayan mountain range. It offered an unobstructed view of China's distant test site, assuming one could manage to hoist a sufficiently powerful electronic eye to its summit.

Several months after the Chinese nuclear test, a young doctor at the University of Washington Hospital in Seattle was doing his rounds when he heard his name paged over the intercom. When he arrived at the front lobby, he was confronted by a sinister-looking man in dark glasses and a trench coat. "Robert Schaller?" The enigmatic visitor pulled open one side of his coat to reveal something inside. Jutting from an inner pocket was an airline ticket. "How would you like to go to the Himalayas?" the man inquired.

The CIA, the stranger explained, required a specialist in medicine, electronics, and mountain-climbing—a combination of skills that produced relatively few candidates. Schaller was one of those few. In exchange for his service and silence, the agency offered a considerable stipend of \$1,000 per month.



Unable to resist the generous salary, patriotic employment, and the once-in-a-lifetime mountaineering opportunity, he hastily agreed. His training was scheduled to begin almost immediately.

Over the following months, Schaller's colleagues at the hospital grew curious regarding his rash of absences. He often returned from a vacation having lost a few pounds and gained a few injuries, but when pressed for an explanation, he was evasive. His official cover story was that he was being trained as a scientist-astronaut, but he declined to elaborate. The true nature of his outings was a closely guarded secret, withheld even from his own family.

Each training mission began at an airport where the recruits used a canvas tunnel to board an airplane with blacked-out windows. Schaller often traveled with an assortment of citizen-spy companions, including Tom Frost, a climber famed for his Yosemite exploits, and expedition leader Captain Mohan Singh Kohli, a mountaineer renowned for his Everest expeditions. Many of the others were unfamiliar to Schaller, but he assumed they must be scientists, considering their knowledge of nuclear technology.

Over a period of months, he and the other operatives became acquainted with the subtleties of leaping from helicopters, demolishing targets with plastic explosives, and handling the experimental atomic-powered hardware that had been custom-built for their mission. Also, to prepare for the climb ahead, the men were required to repeatedly drag this equipment up formidable cliffs in the Alaskan wilderness.

In the fall of 1965, a year after the first Chinese nuclear bomb test, the crew of clandestine climbers assembled at the Sanctuary, a natural fortress of Himalayan mountain peaks that encircled their

ultimate objective: Nanda Devi. Only six souls had previously managed to summit the 25,000-foot behemoth—known by the locals as "the Goddess"—and of those six only three had survived the dangerous descent. Captain Kohli and his crew anticipated an especially complicated climb thanks to the heavy surveillance package they had to heft up the mountain with them. Nonetheless, Schaller and his mountaineering compatriots were eager to embark on the historic ascent.

Together the dozen climbers and Sherpas slowly scaled the side of the Goddess. By day the extra equipment hindered their upward progress, but by night the atomic contraption provided a pocket of warmth for the adventurers. Nestled within the 40-pound nuclear generator was sufficient plutonium to power the surveillance package for a thousand years, thereby providing the U.S. and India with uninterrupted observation of Chinese nuclear bombs and Inter-Continental Ballistic Missile (ICBM) tests.

For several days the crew clambered up the face of Nanda Devi as Schaller cataloged the journey with his camera and diaries. The gaggle of

makeshift secret agents crossed the crevasse-riddled glaciers with the help of steel-spiked shoes and ice axes, gradually making their way to High Camp—the last stop before the summit. The Goddess's perilous

peak stood a mere 1,000 feet above them. But as the team settled in, the sky around Nanda Devi grew dark and restless. The frigid air mingled with moisture, and the stew swiftly thickened into a savage autumn blizzard.

Faced with the threat of being brushed off the mountain by the atmospheric temper tantrum, expedition leader Captain Kohli concluded that the team must turn back, postponing the mission until

To the best of Schaller's knowledge, the Central Intelligence Agency never managed to reacquire its missing nuclear appliance.



■ A climber gazing across at India's Nanda Devi.

the spring climbing season. Kohli ordered that the surveillance package be lashed to the mountainside, much to the surprise and chagrin of his fellow climbers. He reasoned that the team could reacquire the equipment on the next ascent rather than hauling it up the mountain again. The team tied down the antenna, two transceiver sets, and nuclear generator on a rocky outcropping, then hastily fled from the detestable weather.

The following spring, the team returned with plans to retrieve their nuclear parcel and tote it the remaining distance to the mountain top. When they reached High Camp, Schaller and his comrades sought out the crag that had cradled their abandoned equipment throughout the winter, but their stash was nowhere to be seen. A quick survey of the scene suggested that the stone ledge had been sheared from the mountainside by an avalanche, presumably embedding the generator and

its seven cigar-shaped plutonium rods deep into the ice fields below.

No one could be certain what would become of the plutonium in the glacier's clutches, but there was cause for great concern. There were two equally alarming prospects: The nuclear fuel might fall into the wrong hands, leading to any number of diabolical designs; or the slab of migrating ice might slowly grind the plutonium into a paste and deposit it into the Sanctuary melt waters, contaminating the vital Ganges River with four pounds of radioactive material.

For the next two years, the CIA sent scores of Geiger-counter-carrying climbers and specially outfitted helicopters to comb the ice fields for any trace of the power plant. Meanwhile, Schaller and his team scaled a neighboring mountain and successfully installed a similar explosion-observing, missile-monitoring apparatus. They then joined

the ongoing search efforts to locate the misplaced plutonium, but aside from a few Geiger counter clicks, there was not a trace to be found. During one of these subsequent climbs, Schaller took the opportunity to steal away early in the morning and summit the elusive Nanda Devi. Ever the documentarian, Schaller snapped a photo of himself at the summit for posterity.

As the final Himalayan expedition drew to a close, the team's official government operative asked to borrow Schaller's photographs and journals to help him file the mission report. Schaller happily complied, but after several months the documents remained unreturned. All requests for the materials were rebuffed, the CIA citing the need for security. Additionally, although the doctor was awarded the Intelligence Medal of Merit for his contributions, the two agents who presented the medal in a private ceremony were not allowed to leave the medal with him. Even today, decades after the espionage operations, Schaller's requests for his documents are met with letters stating that "the CIA can nei-

ther confirm nor deny the existence or nonexistence of records responsive to your request."

Schaller's marriage, strained by the secrecy of the covert missions, collapsed after 13 years. But he went on to establish himself as a brilliant pediatric surgeon at a children's hospital in Seattle. He remained silent regarding the clandestine climbing operations until 2005, when the expedition leader Captain Kohli released a book detailing their shared Himalayan adventures.

To the best of Schaller's knowledge, the Central Intelligence Agency never managed to reacquire its missing nuclear appliance. A water sample from the Sanctuary in 2005 showed troubling hints of plutonium-239, an isotope that does not occur naturally. Years, decades, or centuries from now, the corpse of the rogue generator may yet rise from its icy grave and exact a radioactive revenge upon humanity. However, the CIA can neither confirm nor deny the existence or nonexistence of a disaster approximating the aforementioned depiction.

SPRING HEELED JACK

A menacing apparition leaps through London, terrorizing its citizens for more than a century

In 1808, a letter arrived for the editor of the *Sheffield Times*. It spoke of how "Years ago a famous Ghost walked and played many pranks in this historic neighbourhood," and identified the apparition as the "Park Ghost or Spring Heeled Jack." The ghost, the author recounted, had been known to make enormous leaps and frighten passersby, but had vanished when "a certain number of men went with guns and sticks to test his skin." The letter describes a being that would menace the United Kingdom for a century.

In September 1837, 30 years after the *Times* received that unusual letter, a Sheffield businessman taking a late walk home saw a man bound over a tall stone cemetery fence. In the subsequent police report, the witness said that the extraordi-

nary jumper was of a muscular build, had glowing red eyes, and bore devilishly pointed ears. The man was not attacked or harassed by the bizarre individual, making him one of the lucky few to see him but escape unscathed. The police report born on that crisp autumn night is the first verifiable record of the malfeasant who would come to be known as

Spring Heeled Jack.

A short time later, a group of three women and a man were outside Blackheath Fair, a suburb of London, when an assailant leaped among them. The man and two of the women fled, leaving young Polly Adams behind. She was found in more or less the same spot several minutes later, after her friends had summoned police help and returned. Her blouse was ripped off, and she described a "devil like" man who'd torn at her clothes with corpse-cold hands and scratched at her breasts and stomach with iron



■ Spring Heeled Jack was often depicted as a devil-like fiend in pulp-fiction "penny dreadfuls."

clawed fingers. He jumped away, laughing with mirth. Of the attacker, the police could find no sign.

In October of that year a woman named Mary Stevens reported an encounter with an oddly dressed man who leaped out of the shadows in South London, gripped her tightly, and began to kiss her face. She cried out and raised an alarm, and was released before help arrived. Her attacker wasn't found.

The very next day the darkly dressed character landed in the middle of a road. An oncoming carriage pulled hard to avoid him, causing it to spin out of control and tip. Witnesses reported that the perpetrator escaped by bounding over a nine-foot wall, laughing all the way. Once more, the police of London were left without a lead.

She described a “devil like” man who’d torn at her clothes with corpse-cold hands and scratched at her breasts and stomach with iron clawed fingers.

Attacks continued through the fall. The press reported that the attacker's method was to lurk behind a high wall or hedge and leap out at the unsuspecting. The villain seemed to favor dark-haired young women, but would happily jump out and slap a man if one was convenient. Vigilante bands were formed to patrol the streets. Once the word was out, city mayors and newspapers began to receive letters from people who said they'd suffered similar attacks but had been too frightened to report them.

The sinister figure appeared again in October, and for the first time the police at the scene found something of interest: a pair of tracks in the mud so deep that they must have been made from a great height. One of the investigators noted that

the tracks hinted at some gadgetry on the suspect's shoes, and speculated that it might be "some sort of compressed springs." At the time no one saw fit to make molds of the prints, but the story got out, and from it the media affixed the name "Spring Heeled Jack."

By the time that winter set in, people thought the attacks had ended. But in February 1938, Spring Heeled Jack once again sprang upon London. A woman named Lucy Scales was walking home with her sister when Jack jumped out of the darkness and belched a gout of blue flames into Lucy's face. On the ground and in pain, Lucy watched as the infamous Spring Heeled Jack turned and jumped away.

A few nights later, Jane Alsop was spending a quiet evening in her London home when there came a great banging on the door. When she opened it, there stood a man in a cloak and cap. He told her, "I'm a police officer. For God's sake, bring me a light, for we have caught Spring Heeled Jack in the lane!" Excited to see the infamous criminal arrested, Jane hurried to comply. But when she handed the candle over, the man held it close for her to see that he was not a officer of the law. His eyes glowed red above an oversized nose. He spit a burst of flame at the girl and began tearing at her clothes. Unable to fight free, she screamed helplessly. Her father and sisters came running; Jack released her, and began bounding down the street to escape. Soon he vanished into the night.

Spring Heeled Jack went in and out of notoriety over the years. In 1872, he jumped amid a squad of soldiers and slapped one soundly. One of the other soldiers claimed to have shot Spring Heeled Jack, but other than a hollow, metallic sound, like shooting a bucket, all it did was raise Jack's ire and send him chasing after the soldiers with his streams of blue flame. After bothering the soldiers for several consecutive nights, a mob caught sight of Jack and made chase. They too claimed to have shot him, but he never slowed, and jumped right out of the area.

Some theorize that Spring Heeled Jack was nothing more than a drunken noble who set out to win a bet and in so doing spawned a conspiracy of imitators. An anonymous letter written to the Lord Mayor of London in 1838 claimed to offer information about certain individuals "of the highest ranks of life" who had made a wager with "a foolhardy companion" to have him dress up in frightening costumes and terrorize the nearby villages. The prime suspect associated with this theory was Marquess of Waterford Henry Beresford, an Irish nobleman widely known for his drunken brawling, contempt for women, and generally rowdy behavior. The Marquess, however, had a solid alibi during the time of several of the key incidents, and the attacks didn't stop after his death in 1859.

In 1904, the final incident formally attributed to Spring Heeled Jack occurred in Liverpool—96 years after a newspaper editor in Sheffield had first heard of him. But according to some it was only the beginning. Between 1938 and 1945, Cape Cod, Massachusetts, was haunted by a being very similar to Spring Heeled Jack. During one incident in Provincetown, the ghost was cornered by a dog and the owner peppered the apparition with



■ Jack during one of his trademark jumps.

a blast of buckshot. In describing the incident to police, the witness said, "The darned thing just laughed and jumped my eight-foot fence in one leap."

Who or what Spring Heeled Jack really was may never be known. But considering the long trail of eyewitnesses, police reports, and physical evidence he left behind, it is difficult to dismiss Spring Heeled Jack as the product of overactive imaginations. Perhaps one day, when the world needs a springy villain once again, he will return.

SUBMERSIBLE AIRCRAFT CARRIERS

Underwater aircraft carriers bring “a storm from a clear sky”

On September 9, 1942, at about 6:00 A.M. Pacific War Time, a lookout on the U.S. Oregon coast spotted a single incoming aircraft. The small, unmarked plane sputtered and popped as it flew through the dawn mist. It slowly made its way over a heavily wooded area that was known to be particularly prone to forest fires, and dropped a pair of cylinders from a low altitude. Soon a column of smoke became visible from the forest as the strange plane turned around, its distinct engine noise fading back toward the ocean.

Howard “Razz” Gardner—the lookout who had first spotted the aircraft—immediately dove into the thick forest to battle the developing blaze. By the time the larger support crew penetrated the woods with their firefighting equipment four and a half hours later, Gardner and a fellow lookout had managed to wrestle the fire into submission. As the crew helped to mop up the last of the smoldering mess, the investigators found the remains of the offending ordnance. The fragments of the phosphorus incendiary bombs were stamped with Japanese markings.

The event came to be known as the Lookout Air Raid, and it marked the first time in history that the continental United States was bombed by an enemy aircraft. It was determined that the aircraft responsible was a Yokosuka E14Y floatplane, and that it had managed to reach the U.S. coast because it had been launched from an unlikely platform: a Japanese submarine lingering just offshore.

The world’s militaries had been dabbling in submersible aircraft carriers for decades, but the technology had long proven problematic. In the mid-

1920s, the British Royal Navy became the first to build a working prototype. An experimental single-plane hangar was fitted to the front of the conning tower on the HMS *M2* submarine, providing the vessel with an airborne reconnaissance vehicle. The unarmed, lightweight biplane was crafted from wood, fabric, aluminum, and steel, and while not in use it sat nestled inside its tiny sealed cocoon with its delicate wings folded.

Once the submarine reached the surface, the plane’s support crew could open the watertight vault door, extract the slumbering aircraft, unfurl its wings, and start the engine. Within minutes, a steam-powered catapult would heave the vehicle into the sky with its crew of two to scan the sea for enemy ships. When the scouting mission was complete, the pilot would land the pontooned plane in the water alongside the submarine. A crane arm could then snag the aircraft and winch it back aboard, where it would once again be stuffed into its nook to await future flights.

The project showed some promise, but in 1932 the *M2* mysteriously sank with all hands lost.

Though the exact circumstances were never determined, the sinking was blamed on water entering through the hangar door. Due to the design's dubious utility and inherent vulnerability, the Royal Navy decided to abandon the concept of submersible aircraft carriers.

Many other militaries continued to tinker with such contraptions, however, including the French *Surcouf* submarine, which was completed in 1934. It was the most massive submarine ever constructed, brimming with weapons and sporting a

which sank the *Surcouf*, killing all on board. The precarious nature of the French crew's allegiance led many to suspect that the sinking was deliberate, though no evidence was ever found to support this theory.

Following the expensive failures of the *M2* and the *Surcouf*, the United States and Italy abandoned their plans to construct similar vessels. But the Imperial Japanese Navy managed to quietly master the art, and during the war the majority of its sub fleet included integrated aircraft hangars. Most of



* A seaplane being launched from an *M2* submarine.

single-plane hangar in the style of the *M2*. When the Nazis invaded France in 1940, the British Royal Navy blockaded the French ships in their ports to prevent them from falling into the hands of the German Kriegsmarine. Each was given the option to rejoin the war against Germany or be destroyed. After a brief exchange of fire between the *Surcouf* and the British left several sailors dead, the French submarine surrendered.

The battle drove a wedge of suspicion between the submariners and their new commanders. Nevertheless, the giant sub worked in uneasy cooperation with the Allies in the early years of the war. Its true potential was never realized, however, due to a collision with an American freighter in 1942,

them—including the I-25 that launched the attack in Oregon—were single-plane hangars similar to the English and French subs. But throughout the war, the Japanese significantly improved upon the submersible aircraft carrier concept.

Japan's first attempt to expand the platform resulted in its AM Type submarines, which carried a pair of bomber planes, but these subs suffered from poor underwater performance. The lessons learned from the AM Type, however, led to the development of the Sen Toku, Japan's most menacing oceangoing weapon. Translated literally as "secret submarine attack," the Sen Toku was developed for a single purpose: to launch a surprise attack against targets on the East Coast of the United States. The

Allies had won the war in Europe, so the bulk of the United States' military equipment was concentrated in the Pacific theater. Japanese military planners considered using their versatile new weapons to sneak up on Washington, D.C., or New York, but they ultimately decided to attack the Panama Canal from the east, where defenses were practically non-

existent. The first two Sen Toku vessels set sail for Panama in mid-1945.

Shortly after getting underway, however, the Sen Toku and their attendant submarines were ordered to return to deflect an imminent Allied invasion of



■ *The massive Surcouf surfaces.*

existent. The first two Sen Toku vessels set sail for Panama in mid-1945.

The I-400 and I-401 were the largest submarines the world had ever seen, each of them crewed by almost 200 men. They had a range of 37,500 miles, enough to circumnavigate the globe one and a half times. Nestled inside each submarine's hangar was a set of three fast and agile dive bombers called Seiran, a Japanese word meaning "storm from a clear sky." Once the subs rounded the tip of Africa and crossed the Atlantic, their mission would be to emerge from the sea, open the giant hangar doors, and thrust their attack planes into the undefended skies of Panama. The Seiran would then bomb the locks unhindered. If successful, such an attack would spill Gatun Lake into the locks and ruin the machinery, severely crippling U.S. shipping and supply efforts.

For months the submarine aircraft carrier crews practiced and perfected their attack strategy for the Panama run. None of the pilots were expected

to survive the attack, so each was presented with a *tokko* short sword, which symbolized the ultimate sacrifice. It was to be an utterly victorious surprise attack reminiscent of Pearl Harbor.

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In late August 1945, about two weeks after the end of hostilities, a United States Navy destroyer

JAPAN'S GERM WARFARE

The Japanese Navy's original mission for the I-400 submarines was even more sinister than an attack on the Panama Canal. Military planners intended to secretly sail westward from Japan to the U.S. East Coast, where an attack would be unexpected, and use its three Seiran planes to drop rats and fleas infected with bubonic plague, cholera, typhus, and other diseases upon New York, Washington, D.C., and other cities along the Eastern seaboard.

These biological weapons were developed at Japan's Unit 731, an installation disguised as a water-purification plant. The Allied forces had long suspected that Japan was utilizing germ warfare against China, but were unable to conclusively prove their suspicions during the war.

When America was attacked by Japan's balloon-borne bombs, U.S. officials were concerned that these might include some of Japan's infected fleas, but no such biological payloads were discovered.

Several epidemics of cholera, typhoid, anthrax, and bubonic plague were reportedly caused in China by Japan's "Uji" bombs, which were designed specifically to burst hundreds of feet above the ground and rain infected fleas upon the populace. By some estimations, these attacks triggered outbreaks that killed as many as 50,000 Chinese people over six years. According to Chinese reports, infected houses, hospitals, and other buildings were burned and had to be left untouched for decades, and fears of further outbreak still haunt the cities today.

intercepted the unfamiliar Japanese submarines as they made for their home port. As the U.S. sailors sidled alongside, they were astonished by the size of the behemoths. They were much more massive than any built before them, three times larger than typical submarines. In addition to their empty airtight hangars, each Sen Toku had four antiaircraft guns, eight torpedo tubes, and a sizable deck cannon. The subs were each powered by four 7,700-horsepower diesel engines, and they could operate at a depth of 330 feet. Clearly the I-400 series submarines would have been formidable weapons if they had even seen action.

Once the three virgin vessels reached Japan's Sasebo Bay, a team of U.S. Navy experts began to scrutinize their technology. The technicians marveled at the huge hangars and the innovative figure-eight hull reinforcements, but their investigations were cut short when they were informed that the Soviets were sending a team to inspect the captured submarines. Rather than allowing the Soviets

access to the advanced technology, the Americans instituted Operation Road's End. Many Japanese subs, including one of the Sen Toku, I-403, were packed with C-2 explosives and scuttled off the Japanese coast. I-400 and I-401 were covertly sailed to Hawaii, where further secret inspections occurred before they were also destroyed at sea.

The Japanese Sen Toku were the last of their kind. No submersible aircraft carriers have been built since, though the idea does occasionally spark the interest of modern militaries as a means to approach with stealth and attack without warning. In spite of the technical challenges involved, the concept is certainly strategically appealing. Indeed, had the I-400 vessels set off for the Panama Canal just a few months sooner, the storm they brought with them might have altered the course of the war by shattering the critical U.S. supply route through Panama. In some ways, the Allies' victory in the Second World War was much narrower than history implies.



THE SUN GUN

A diabolical application of solar energy

Throughout the Second World War, the town of Hillersleben, Germany, was home to one of the Third Reich's most crucial weapons research centers. At a sprawling facility nestled in the forested hills, a contingent of 150 engineers and physicists developed and evaluated all manner of experimental weapons, a substantial number of which were ultimately adopted by the nefarious Nazi war machine.

When Germany surrendered in May 1945, the scientists at Hillersleben were forced to abandon an assortment of deadly innovations at various stages of completion. Among these were a 600-mm mortar that fired one-ton self-propelled projectiles for up to three and a half miles, a modified Tiger tank that could fire 760-pound rockets up to six miles, and a chainlike projectile made up of small, linked rockets with a range of 100 miles. But the military masterminds' most sinister ambitions were embodied in their behemoth *Sonnengewehr*, or "Sun Gun" project—an orbital weapon intended to exact fiery punishment upon the enemies of the Third Reich, forever establishing their dominance over the genetically inferior *Untermenschen* of the Earth.

The Sun Gun was based on a design originally conceived by Hermann Oberth, a physicist who is widely credited as one of the founding fathers of rocketry and astronautics. In his 1929 book, *Wege zur Raumschiffahrt*, or "Ways to Spaceflight," Oberth presented a scientific description of a hypothetical manned space station orbiting at an altitude of 1,000 kilometers. He detailed potential construction methods using prefabricated sections, described a rotational cycle to produce centrifugal gravity within the station, and outlined a system for periodic resupply missions. Oberth advocated



■ Hermann Oberth (left) stands with one of his earlier rockets, a forerunner to the V-2.

the development of these *Raumstations* to serve as astronomical observatories and telegraph relays, in addition to Earth-observing activities such as meteorology, search-and-rescue, and military intelligence. What interested the Nazi scientists, how-

ever, was his suggestion that a specially engineered 100-meter-wide concave mirror could be used to reflect sunlight into a concentrated point on the Earth. Oberth had theorized that the intense heat could be used to produce electricity with steam turbines, but the Nazi weaponeers envisioned a colossal heat ray that could vanquish humanity.

Starting from Hermann Oberth's 1929 design, the ambitious physicists of Hillersleben blueprinted a truly gargantuan weapon 100,000 times more powerful than Archimedes' mythical death ray. To achieve the desired destructive power, their calculations required a parabolic mirror of at least three square kilometers, at an orbit of 8,200 kilometers. After considering a number of reflective materials, the scientists settled upon metallic sodium, a relatively abundant element. Under ordinary conditions, pure sodium tarnishes quickly and reacts violently to moisture. However, the researchers reasoned that these shortcomings would not pose any problem in the virtually vacuous exosphere.

To heft the prebuilt pieces into orbit, engineers planned to employ a beefed-up version of the trail-

blazing-but-treacherous V-2 rocket that Germany had been using to terrorize London. This "A11" multistage variant was designed by Wernher von Braun, and it was still undergoing development at the V-2 facility in Peenemünde. Once complete, the A11 rockets would have sufficient range to deliver people into space and to send Nazi munitions directly to the shores of the United States.

Inside the living area of the station, electricity would be provided by special steam-driven dynamos that would utilize the heat of raw solar radiation. The station's complement of Nazi astronauts would wear magnetic shoes to accommodate working in weightlessness, and their oxygen would be constantly replenished by vast onboard greenhouses filled with CO₂-thirsty pumpkin plants. The crew of a fully operational Sun Gun station would keep a sharp eye on enemies of the Reich, receiving encoded orders via radio or wireless telegraph.

When commanded to attack a terrestrial target, the crew would engage a network of rocket thrusters to rotate the massive reflector into a carefully calculated orientation. Once in position, the mir-

DEATH RAY OF THE ANCIENTS

The Sun Gun concept was essentially a scaled-up version of Archimedes' ancient and oft-debated "Death Ray." In 212 B.C., the Roman Republic sought to seize the city of Syracuse

from its Greek inhabitants. Some accounts claim that the initial attack was repelled by Archimedes, the astonishingly talented Greek mathematician and physicist. He is said to have used an array of sunlight-concentrating copper mirrors to set the approaching Roman ships aflame. Modern scientific attempts to confirm or deny the feasibility of such a weapon have met with varying outcomes. Most prominently, the myth was "busted" on the television program *MythBusters* in 2006. The 'Busters found that an array of metal mirrors could indeed ignite a wooden ship, but only after a tactically tricky exposure of several minutes. Although the authenticity of the ancient legend is questionable, the principle behind it is fundamentally sound.



ror's curvature would converge the sun's mighty rays into a focal point on the Earth's surface, instantly pouring a cone of raw, superconcentrated solar radiation upon the target site. Hypothetically this beam would be hot enough to scorch fields, incinerate cities, vaporize reservoirs, and melt screaming onlookers like wax dummies. Any nation lacking space-capable rockets would be utterly defenseless against the onslaught. Once the desired destruction threshold was reached, the mirror would be tilted back into a safe orientation—but not before creating a bit of collateral damage as its focal point dragged across the landscape.

Hypothetically this beam would be hot enough to scorch fields, incinerate cities, vaporize reservoirs, and melt screaming onlookers like wax dummies.

The supervillainous project was stalled in the spring of 1945 as the impending Allied victory became increasingly evident. American intelligence agencies immediately invoked Operations Overcast and Paperclip to extricate German scientists and equipment ahead of the Soviets. Lieut. Col. John A. Keck, chief of the Ordnance Service's enemy technical intelligence branch in European theater, led the interrogation of a number of Nazi researchers. The German engineers described their participation in the development of the V-2 and disclosed details regarding several other nearly perfected technologies: a submarine-based V-2 launch system, an infrared sniper scope, and an antiaircraft rocket capable of autodetonating within ten yards of a target. In addition, they handed over the schematics and calculations for their formidable Sun Gun concept. Considering the Nazi scientists' other impressive achievements, Lieutenant Colonel Keck and his team

of hard-headed engineers took the death star concept seriously. "We were impressed with their practical engineering minds," Keck said of the Hillersleben researchers, "and their distaste for the fantastic."

Many American scientists, however, were more skeptical about Sun Gun's feasibility. Astronomical amounts of time, money, and resources would be required to hoist the hundreds of tons of equipment into orbit, not to mention the million or so tons of metallic sodium. Furthermore, there were doubts regarding whether a single parabolic mirror could concentrate destructive levels of energy upon such a distant focal point, though this problem could be overcome by building multiple Sun Guns to operate as an orchestrated orgy of annihilation. In spite of the monumental scale of the concept, the physicists from Hillersleben were confident that their *Sonnengewehr Raumstation* was feasible and that its uninterrupted development could have furnished the Fatherland with comprehensive global conquest.

Despite appearances, the Hillersleben researchers were not exclusively sinister. Nestled among the heat-ray-of-doom diagrams, scientists included notes describing the space station's potential as a radio-relay satellite, a weather observation post, a launch pad for the interstellar rocket expeditions, and, of course, Hermann Oberth's original vision to use the giant mirror to generate electricity on Earth.

Many of the German rocket scientists—including Oberth and Wernher von Braun—ultimately opted to put science ahead of patriotism and moved to the U.S. to continue their rocketry research. In addition to their work with U.S. missile defense systems, many of the men went to work for the fledgling space program in the 1950s. The rocket originally slated to carry the Sun Gun segments into space—Von Braun's A11—eventually became the foundation for the Saturn V that carried the *Apollo* astronauts into orbit. Through hard work and perseverance, these pioneers of rocketry finally managed to build a rocket that could reach past London and into the frontier of space.

SYLBARIS THE SURVIVOR

An unexpected volcanic eruption wipes a city off the map, but one man lives to tell his tale

In the twilight hours of May 8, 1902, a ship went to anchor at the port of Saint-Pierre, a charming city at the edge of Martinique. The city and its surroundings were shrouded in complete darkness. When the captain awoke the next morning, he discovered something was wrong; it appeared as though his vessel had strayed off course. The island looked nothing like the tropical haven he set out for during his month at sea. This was not "the Paris of the Caribbean," as some called it; instead, the captain stood before a decimated landscape where a lingering haze rose from the scorched island like an apparition escaping to a more forgiving realm.

Where were the red-tiled cottages, the twisting cobblestone streets, the towering cathedral, or sugar cane? Where were all the inhabitants? This could not be Saint-Pierre. Yet the instruments on his ship were accurate and his navigation was sound. A journalist later wrote of the stark realization that occurred: "The land appeared more clearly and the captain no longer asked whether he was dreaming, but rather if he was mad... He saw the ruins... And the mountain which continued to smoke and grumble. And he understood." A closer look into the city revealed a smoldering terrain, rubble, and gas-

ruptured corpses. Though incredibly, amid the ruins there remained a survivor, one man alone. His name was Ludger Sylbaris. Born in 1874, he would eventually be hailed as the sole survivor of a cataclysmic disaster and dubbed "the Most Marvelous Man on Earth."

Almost a year earlier, the thriving rum and sugar export businesses that sustained Saint-Pierre were a greater concern to its populace than the increasingly foreboding behavior of the 4,428-foot-high Mount Pelée. On June 22, 1901, a local newspaper, *Les Antilles*, reported,



■ Ludger Sylbaris, unlikely survivor of the eruption of Mount Pelée.

"Around two hectares of trees have been burnt by the sulphurous emissions." The author also noted, "Some openings in the soil have been noticed." Despite this, many believed the volcano to be extinct and thought the news of little consequence. The activity of Pelée was of even less concern to Ludger Sylbaris, who was said to be a short-tempered heavy drinker who frequently brawled and gambled. While his luck with cards was scarce, his fate would prove him to be a fortunate man.

On April 23, 1902, the city was jolted by a series of increasingly menacing tremors. Despite this, many were still hesitant to acknowledge that the magnificent spire of La Montagne was anything more than a pleasing accent to their beautiful island nation. Saint-Pierre's newspapers were among the most dismissive voices in the community. Journalists of the local newspaper *Les Colonies* asserted, "We confess that we cannot understand the panic. Where could one be better off than in Saint-Pierre?" By the time this decree had been written, much of the city was covered in a thick, even dusting of volcanic ash that cloaked the island in a gray shroud.

Driven out of the brush by the oppressive heat, hundreds of fer-de-lance snakes slithered into the streets, delivering panicked, poisonous bites to any animal that got in their way.

The reporters' mild assessments were more the result of political pressure than scientific scrutiny. As a growing fear of a volcanic eruption pervaded the city, many locals had finally begun to depart. This prompted unease among city officials, who were anxious to ensure local elections would proceed as planned on May 11. The ability to leave the island was an option available only to the wealthy, virtually all of whom belonged to the

Progressive Party of Governor Mouttet. The governor encouraged editors at *Les Colonies* to write dispelling articles to curtail further departures. Mouttet took even greater measures when he sent troops to patrol the road leading to the capital city of Fort-de-France, forcing locals to turn back to their homes. The calming words of the newspaper were so successful that many outside the city limits journeyed to Saint-Pierre in belief that it was the safest part of the island.

The growing cacophony of both man and nature went unnoticed by Ludger. Since mid-April the 27-year-old had been serving a one-month sentence behind the brick walls of the Saint-Pierre jail, his punishment for using his cutlass to injure a friend during a violent confrontation. But even this brief incarceration could not overpower Ludger's insatiable thirst, and he managed to escape from his communal cell to enjoy the festivities of a village carnival. At dawn of the following day, Ludger sauntered back into Saint-Pierre, where he was immediately apprehended and returned to jail. This time the prison's overseer relegated him to solitary confinement, a decision that would ultimately save Ludger's life.

On the morning of May 8, 1902, the sun rose for the last time on the city of Saint-Pierre as the world knew it, though this final sunrise was hidden behind a sky blackened by the falling ash. The mercury in local barometers spiked and dipped dramatically, portending the disaster ahead. At ten minutes to eight, a deafening sound pierced the city as four explosions preceded the eruption. A thundering black column of smoke shot up from Pelée even as the mountain began to crumble. An apocalyptic wind burst from the side of the mountain, firing explosive heat and dust directly into the city at 100 miles an hour. Electromagnetic disturbances were registered as far away as Athens and even China. Driven out of the brush by the oppressive heat, hundreds of fer-de-lance snakes slithered into the streets, delivering panicked, poisonous bites to any animal that got in their way. The sky became acrid with dust



■ The devastation caused to Saint-Pierre was massive.

as incandescent gas flows ignited the community's combustibles. The sea began to boil as the annihilation reached the shore, reducing 16 ships in the port to ash. A clock on the wall of the Military Hospital showed Saint-Pierre's final moment represented by the hour and the minute hand melted together at 7:52 A.M. In only a few short minutes, Saint-Pierre and its 28,000 people perished.

A rescuers scoured the ruins of the local school, the crisp pages of the lesson books indicated ironically that at the time of the explosion some of the children were learning of Pompeii's final hours. Before long, looters took to the rubble, claiming jewelry and goods for themselves. There were no signs of life in the wasteland. Britain's vice consul in Guadeloupe arrived after the destruction, noting, "Not a sound was heard from that vast, hideous, dull, grey amphitheatre of death."

Four days after the destruction of Saint-Pierre a remarkable discovery was made. A group of men heard cries from a jail cell, "Gentlemen! Save me! For the Love of God . . . come save a poor prisoner."

They broke the locks on the door, and inside they found Ludger muttering, "Gentlemen, I do not know what has happened or where the other prisoners have gone." He suffered severe burns on his back, hands, feet, and legs, though his face remained unscathed despite the burning gases that crept through his cell door after the eruption. Ludger survived by holding his breath. His reinforced cell, which faced south, was pointed away from the volcano, thereby shielding him from death.

At first many journalists dismissed his survival story as nonsense, but in time the details of his account were verified. Further investigation found that two other citizens of Saint-Pierre had also managed to escape; a shoemaker named Léon Compère-Léandre who lived on the

edge of the pyroclastic flow and a young girl named Havivra Da Ifrile who fled to a nearby cave upon seeing a "boiling red river" bearing down on the city.

Ludger was pardoned for his crimes, and he was soon recruited by P. T. Barnum's "Greatest Show on Earth." He was grouped with an arresting collection of "freaks," including Eli Bowen, the Legless Acrobat; and J. W. Coffee, the thinnest man alive, "requiring two to make a shadow." Ludger was introduced as "A man whose name is written in fire" as he posed in a replica of his fateful Saint-Pierre cell. He loathed the role, but it paid sufficiently to keep him fed and intoxicated.

Sadly, Ludger's circus career was short-lived. During a drunken fight he reportedly stabbed a night watchman at the circus, and he was promptly returned to prison. With that, Ludger Sylbaris—the man who survived a volcanic blast, a river of snakes, and a circus freak show—was subsequently deleted from the public eye with all the swiftness of a cartographer removing the name of Saint-Pierre from his maps.

TERROR ON WALL STREET

A group of radical extremists devastate lower Manhattan . . . in 1920

On September 16, 1920, throngs of brokers, clerks, and office workers poured from the buildings lining New York City's Wall Street as a nearby church bell struck 12 o'clock. The narrow cobblestone street became a river of sputtering automobiles and scurrying pedestrians as financial district employees set out to make the most of their midday break.

Traveling against the current of egressing crowds, an elderly bay horse plodded along Wall Street pulling a nondescript wagon and a driver. The cart came to a stop just around the corner from the New York Stock Exchange (NYSE), across the street from the imposing JP Morgan & Co. bank building. The wagon's driver cast the reins aside, leaped from his perch, and fled from the street with conspicuous haste. As the lunch-going men and women shuffled past the parked wooden cart and its patiently waiting horse, a timer within the cargo compartment quietly counted off its final few seconds.

The intersection of Wall Street and Broad Street was locally known as "The Corner," so named for its collection of influential entities. JP Morgan at that time was the world's most powerful financial institution, ruling over a significant portion of the global economy; just to the north was the U.S. Assay office, where the purity of precious metals was tested many tons at a time; and around the corner stood the home of the NYSE. A U.S. Sub-Treasury and Federal Reserve Bank also stood nearby, housed within the Federal Hall, which had once been the site of the United States Capitol building.

The mood was generally cheery on the warm Thursday afternoon—the sun was shining and the

stock market was up. A celebration was scheduled to take place on Wall Street the following day to honor the 133rd anniversary of the adoption of the U.S. Constitution. It was intended to be a small gathering alongside the statue of George Washington that had been erected at the site of America's first presidential inauguration.

The blast sent an automobile careening through the air as countless jagged iron fragments ripped into the crowd.

At approximately one minute after 12 noon, the abandoned wagon's timer made its final tick. One hundred pounds of dynamite packed with 500 pounds of cast-iron slug violently vomited red-hot shrapnel in every direction. A number of passers-by were instantly vaporized by the heat and pressure of the explosion. The blast sent an automobile careening through the air as countless jagged iron fragments ripped into the crowd. The nearby structures trembled as the shockwave slammed into their

outer walls with tremendous force, shattering windows and turning lobbies into lacerating hailstorms of glass. Many of the cloth awnings that overlooked the street burst into flames. Within a half-mile radius, thousands of plate-glass windows burst in the city's tall buildings, peppering the streets of Lower Manhattan with razor-sharp glass shards.

An Associated Press reporter named George Weston witnessed the blast from the protection of a doorway, and later described the scene:

“[It was] an unexpected, death-dealing bolt, which in a twinkling turned into a shamble the busiest corner of America’s financial center. [...] Almost in front of the steps leading up to the Morgan bank was the mutilated body of a man.

Other bodies, most of them silent in death, lay nearby. As I gazed horrorstruck at the sight, one of these forms, half-naked and seared with burns, started to rise. It struggled, then toppled and fell lifeless to the gutter.”

One of the Stock Exchange's messengers, Charles P. Dougherty, described the scene to a reporter for the *Sun*:

“I saw the explosion, a column of smoke shoot up into the air and then saw people dropping all around me, some of them with their clothing afire.”

As the bustling Stock Exchange shook, its large windows burst inwards. Fortunately most of the occupants were spared injury thanks to the mas-



■ After the smoke cleared, crowds gathered to check out the scene on Wall Street.



■ Curious onlookers gawk at some of the bombing's unlucky victims.

sive silk curtains, which deflected much of the glass. Running was strictly forbidden on the trading floor, so the president of the Stock Exchange sauntered to the rostrum to sound the gong to halt the day's trading as a yellow-green mushroom cloud stretched into the air.

Outside, pandemonium quickly set in. Those who heard the blast from the surrounding blocks rushed into the area to see what had happened, trampling over the bodies of the dead and injured. The air was thick with smoke and dust from the explosion and the ensuing fires. The cobblestone street was scattered with the twisted wreckage of cars, buildings, and humans as the echoes of the explosion slowly faded. A fatally wounded messenger boy pleaded for someone to deliver his securities, and a clerk, having lost his eyes and his feet

in the blast, tried to blindly crawl toward safety. A woman's severed head, still wearing a hat, was stuck to the facade of the JP Morgan building.

Thirty people died in the first few moments, and ten more were mortally wounded. Some 300 other men, women, and children were injured. Many staggered toward the Trinity Church to escape the choking smoke. Another wave of panic rippled through the crowd as word spread that another bomb was set to go off nearby, but the rumor proved untrue.

News of the disaster spread quickly, and within 30 minutes the street was filled with hundreds of New York City policemen and Red Cross nurses who had rushed to the scene by horse, car, subway, and foot. The rescue workers cleared the road for ambulances and used the sidewalk as a makeshift morgue.

Meanwhile well-armed security officers guarded the U.S. Assay office, where \$900 million in gold bars were being stored. Within the hour troops from the 22nd Infantry arrived, marching down Wall Street with rifles and bayonets at the ready.

Little was left of the horse and wagon that brought the destruction upon Wall Street, though the Bureau of Investigation agents found enough fragments to piece together many details. The shoe from a charred, disembodied hoof led the police to the farrier who had shod the horse. The blacksmith remembered the customer, and described him as a Sicilian man of 25 to 30 years old. Additionally, the cast-iron shrapnel slugs that had been packed with the explosives were identified as the weights used on window sashes—through the police were unable to determine their exact source despite visiting hundreds of manufacturers and distributors. The NYPD also gathered up fragments of wagon wheel spokes, leather straps, chunks of canvas, an axle, and a hub cap from the original wagon, and managed to piece together many details with the assistance of veterinarians and wagon builders:

- **HORSE**—Dark bay mare, 15 and three-quarters hands, 15 years, about 1,050 pounds, long mane and stubby foretop, clipped a month before, scars on left shoulder and white hairs on forehead.
- **SHOES**—Hind shoes marked JHU and NOA, about half an inch apart. Front shoes had pads, circle in center reading 'Niagara Hoof Pad Co., BISON, Buffalo, N.Y.'
- **HARNESS**—Single set of heavy wagon harness, old and worn and frequently repaired. Turret rings originally of brass, one broken; the other silver mounted and evidently belonging originally to coach harness.
- **WAGON**—Single top, capacity one and one-half tons, red running gear, striped black with fine white lines. Three-foot wheels on front; four and

one-half on back, of Sarvant patent. Body 5 feet 6 inches high, 53 inches wide, about 8 feet from ground to top of wagon.

Investigators immediately suspected that the bombing was the work of Galleanist anarchists, a group of mostly Italian-born antigovernment radicals who had previously used smaller explosives to draw attention to their cause. Moreover, a pair of Italian-American anarchists had been indicted five days earlier for bank robbery and murder. These suspicions were reinforced by a pile of leaflets found in a mailbox near the blast site, which read:

*“Remember
We will not tolerate
any longer
Free the political
prisoners or it will be
sure death for all of you
American Anarchist Fighters.”*

In a bid to allay fears of a stock market crash, the New York Stock Exchange reopened the day after the explosion under the guise of business as usual. When the workers arrived on Wall Street, the evidence of the previous day's carnage was draped with cloths and the somber mood was draped in patriotism. In spite of the attack, the Constitution Day celebration commenced as planned alongside the unscathed statue of George Washington. What had originally been intended as a small gathering grew into one of the largest crowds in Wall Street's history. The assembled citizens sang "The Star-Spangled Banner" and "America the Beautiful," followed by a rousing speech from World War I hero Brig. Gen. William J. Nicholson.

The Washington Post referred to the bombing as an "act of war," though no one could be certain who the enemy was. The newspaper also wrote, "The bomb outrage in New York emphasizes the extent to which the alien scum from the cesspools and sewers of the Old World has polluted the clear

spring of American democracy." Though the anarchists had not been proven responsible, the U.S. government's ongoing antiradical Palmer Raids were increased in intensity as a consequence of the bombing. Immigrants were aggressively targeted, especially Italians, Russians, and Jews. Thousands of citizens were detained in the name of national security, though most of them clearly had nothing to do with the Wall Street terror plot. Ultimately, the orgy of misguided justice resulted in the deportation of about 10,000 such "radicals."

Investigators also became suspicious of a tennis champion named Edwin Fischer who had apparently predicted the attack with astonishing accuracy. Fischer had been warning his friends of an impending bomb attack on Wall Street, sending them postcards enjoining them to leave the area before September 16. When interrogated by the police, he claimed to have received the messages "through the air." He also claimed to be a sparring partner for the world heavyweight boxing champion Jack Dempsey, and he wore two business suits at once over a set of tennis clothes. Investigators decided that Fischer's warnings were not particularly intriguing once they learned that he had made a regular habit of predicting explosive violence on Wall Street, having previously provided a wide variety of dates. Officials turned him over to the Amityville Asylum, where he was diagnosed as insane but harmless.

Wall Street soon became a symbol of patriotism in the eyes of the country, and stock trading came

to be viewed as an act of defiance against the terrorists. Before the attack a number of outspoken citizens had decried the unchecked growth of power underway on Wall Street, but many of those voices fell silent in light of the new public sentiment. Those critics who continued to voice their concerns

were denounced as supporters of violence and terror, a trend that rapidly smothered all public debate on the matter.

The New York police vowed to apprehend the perpetrators of the terrible crime, but no arrests were ever made in the

case. The NYPD and FBI officially gave up on the case in 1940, having never even identified any likely suspects. No group or individual ever made a credible claim of responsibility. Some historians have suggested that the incident may have actually been a botched attempt to rob the gold-filled Assay Office nearby, yet no compelling evidence has been found to support this notion.

No plaque marks the site of one of the deadliest terror attacks in U.S. history—only a pockmarked facade stands as a memorial to the loss of life and liberty that struck America in 1920. The owners of JP Morgan have repeatedly stated that they will never repair the superficial scars. "Replacing those great blocks would be inordinately and unnecessarily expensive," one Morgan partner pointed out. "And besides, it's right and proper that they should stay there."

The event remained as New York's deadliest terror attack until September 11, 2001.

Thousands of citizens were detained in the name of national security, though most of them clearly had nothing to do with the Wall Street terror plot.

TESLA'S TOWER OF POWER

The brilliant engineer's grand design for wireless energy transmission was ahead of its time

In 1905, a team of construction workers in the small village of Shoreham, New York, labored to finish erecting a truly extraordinary structure. Over a period of several years, the men had managed to assemble the framework and wiring for the 187-foot-tall Wardenclyffe Tower, in spite of severe budget shortfalls and multiple engineering snags. The project was overseen by its designer, the eccentric yet ingenious inventor Nikola Tesla, best known as the father of alternating current (AC) technology. Atop his tower was perched a 55-ton dome of conductive metals, and beneath it stretched an iron root system that penetrated more than 300 feet into the Earth's crust. "In this system that I have invented, it is necessary for the machine to get a grip of the earth," he explained, "otherwise it cannot shake the earth. It has to have a grip . . . so that the whole of this globe can quiver."

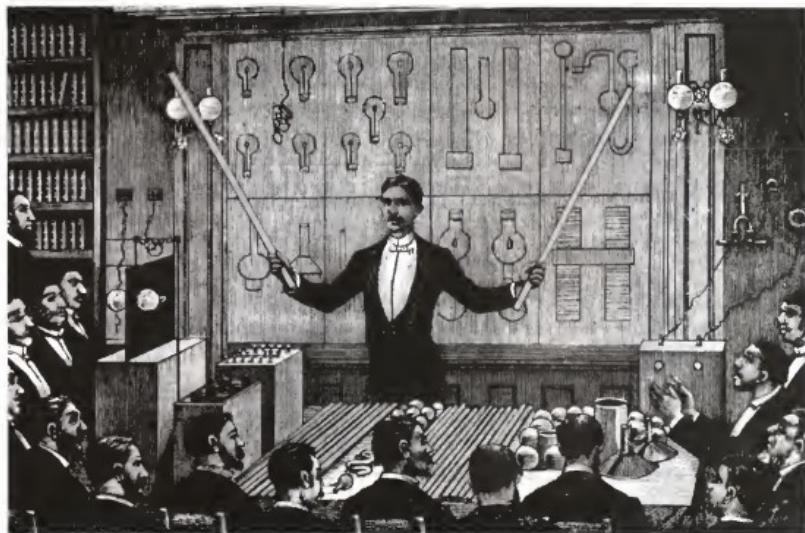
Though the system was far from completion, it was rumored to have been tested on several occasions, with spectacular, crowd-pleasing results. The ultimate purpose of this unique structure was to change the world forever.

Tesla's inventions had already changed the world on several occasions, most notably with AC technology in the well-publicized "battle of currents." He had emerged victorious after proving that AC was safer and more practical than Edison-brand direct current. Tesla had also brought about such advances as the Tesla coil, the radio transmitter, and the fluorescent lamp. By 1900 Tesla was widely regarded as America's greatest electrical engineer.

In 1891, Nikola Tesla gave a lecture for the members of the American Institute of Electrical Engineers



■ *Tesla's Wireless Broadcasting Tower.*



■ *Tesla delivers an electrifying lecture on AC power.*

in New York City, where he made a striking demonstration. In each hand he held a gas discharge tube, an early version of the modern fluorescent bulb. The tubes were not connected to any wires, but nonetheless they glowed brightly during his demonstration. Tesla explained to the awestruck attendees that the electricity was being transmitted through the air by the pair of metal sheets that sandwiched the stage. He went on to speculate how one might increase the scale of this effect to transmit wireless power and information over a broad area, perhaps even the entire Earth. As was often the case, Tesla's audience was engrossed but bewildered.

Back at his makeshift laboratory at Pike's Peak in Colorado Springs, the eccentric scientist continued to wring the secrets out of electromagnetism in hopes of discovering a practical means to transmit wireless power. To test his theories about the conductivity of the Earth and the sky, Tesla needed to

produce the first lightning-scale electrical discharges ever accomplished by mankind. For this purpose he erected a 142-foot mast on his laboratory roof, with a copper sphere on the tip. The mass of electrical wires was then routed through a high-voltage transformer—a giant version of his Tesla coil—in the laboratory below. On the night of his experiment, a one-second test charge momentarily set the night alight with an eerie blue hum. Satisfied, Tesla ordered his assistant to fully electrify the tower.

Though his notes do not specifically say so, one can only surmise that Tesla stood at Pike's Peak and cackled diabolically as the night sky over Colorado was cracked by the lightning machine. Colossal bolts of electricity arced hundreds of feet from the tower's top to lick the landscape. A curious blue corona soon enveloped the crackling equipment. Millions of volts charged the atmosphere for several moments, but the awesome display ended abruptly when the power

failed. All of the windows throughout Colorado Springs went dark as the local power station's industrial-sized generator collapsed under the strain.

Tesla's unusual test confirmed that the Earth itself could be used as an electrical conductor, and verified some of his suspicions regarding the conductivity of the ionosphere, the electromagnetically charged region at the uppermost part of the atmosphere. In later tests, he recorded success in an attempt to illuminate lightbulbs from a distance, though the exact conditions of these experiments have been lost to history. From these successes, Tesla was convinced that his dream of worldwide wireless electricity was feasible.

In 1900, famed financier J. P. Morgan learned of Tesla's convictions after reading an article in *Century Magazine* wherein the scientist described a global network of high-voltage towers that could one day control the weather, relay wireless text and images, and provide ubiquitous electricity via the atmosphere. Morgan immediately invested \$150,000 to relocate Tesla's lab to Long Island to construct a pilot plant for this "World Wireless System," and the construction of Wardenclyffe Tower and its dedicated power plant began the following year.

Millions of volts charged the atmosphere for several moments, but the awesome display ended abruptly when the power failed.

In December 1901, a scant few months after construction began, a competing scientist named Guglielmo Marconi executed the world's first transatlantic wireless telegraph signal. Tesla's investors were deeply troubled by the development, despite the fact that Marconi borrowed from 17 Tesla patents to accomplish his feat. Though Marconi's plans were considerably less ambitious, his appa-

ratus was also considerably less expensive. Work at Wardenclyffe continued, but Tesla realized that his competitor's success with simple wireless telegraphy had greatly diminished the likelihood of further investments in his own grand project.

In 1908, Tesla described his sensational aspirations in an article for *Wireless Telegraphy and Telephony* magazine:

"As soon as completed, it will be possible for a business man in New York to dictate instructions and have them instantly appear in type at his office in London or elsewhere. [...] An inexpensive instrument, not bigger than a watch, will enable its bearer to hear anywhere, on sea or land, music or song, the speech of a political leader, the address of an eminent man of science, or the sermon of an eloquent clergyman, delivered in some other place, however distant. In the same manner any picture, character, drawing, or print can be transferred from one to another place. [...] More important than all of this, however, will be the transmission of power, without wires, which will be shown on a scale large enough to carry conviction."

Tesla's plan, in essence, was to "pump" the planet with electricity that would intermingle with the natural telluric currents that move throughout the Earth's crust and oceans. At the same time, towers like the one at Wardenclyffe would fling columns of raw energy skyward into the electricity-friendly ionosphere 50 miles up. To tap into this energy, customers' homes would be equipped with a buried ground connection and a relatively small spherical antenna on the roof, thereby creating a path for the ionospheric electricity to close the circuit back to Earth. Oceangoing ships could use a similar antenna to draw power from the network while at sea. In addition to electricity, these currents could carry information over great distances by bundling radio-frequency energy along with the power, much like the modern technology that sends high-speed Internet data over power lines.

Given his supporting experimental data and previous engineering accomplishments, there was little reason to doubt the veracity of Tesla's claims. But the construction of the power station, the huge wooden tower, and the 55-ton conductive dome had rapidly depleted the original investment money, leading to chronic funding shortages. The complications were compounded by a stock market crash in 1901, which doubled the cost of building materials and sent investors scurrying for financial cover.

The Wardenclyffe team tested their tower a handful of times during construction and the results were very encouraging; but the project soon devoured Tesla's personal savings, and it became clear that no new investments were forthcoming. In 1905, having exhausted all practical financial options, the construction efforts were abandoned.

Upon the project's demise, Tesla decried the "blind, faint-hearted, doubting world," stating that his World Wireless System was "not a dream, it is a simple feat of scientific electrical engineering, only expensive." He also assured the public that "all that was great in the past was ridiculed, condemned, combatted, suppressed—only to emerge all the more powerfully, all the more triumphantly from the struggle."

If Tesla's plans had come to fruition, the pilot plant would have been merely the first of many. Such "magnifying transmitter" towers could have peppered the globe, saturating the planet with free electricity and wireless communication as early as the 1920s. Instead, the futuristic facility's potential went untapped for over a decade, until the tower was finally demolished for salvage in 1917.

The fall of Wardenclyffe thrust the brilliant inventor into a deep depression and financial distress, and in the years thereafter, his colleagues began to seriously doubt his mental well-being. He developed a tendency to bring home and care for injured pigeons he encountered during his daily walks, and he began washing his hands compulsively and refusing to eat any food that had not been disinfected through boiling. But his mind remained pregnant with groundbreaking ideas, as he demonstrated when he described radar technology in 1917, almost 20 years before it became a reality. In 1928, aged 72 years, he filed one of his last patents; it described an ingenious lightweight flying machine that was an early precursor to today's tilt-rotor Vertical Short Takeoff and Landing (VSTOL) planes such as the V-22 Osprey.

Nikola Tesla shuffled off this mortal coil in 1943, suffering a heart attack alone in his hotel room. Though he kept copious diaries of his experiments and ideas throughout his life, they were notoriously vague and lacking in technical details. He preferred to rely on his photographic memory for such nuances, and therefore much of his knowledge went with him to the grave. Some modern experiments, however, do support Tesla's contention that wireless electricity is not only feasible but may have even been a superior alternative to the extensive and costly grid of power lines that crisscross our globe today.

Had Wardenclyffe been completed without interruption, the Information Age might have begun almost a century sooner, furnishing the citizens of the early 1900s with instant access to electricity, pirated phonograph recordings, and lewd photos of bare-ankled floozies on the TeslaNet. Perhaps one day we will enjoy the future that Tesla envisioned, albeit a bit behind schedule.



■ Nikola Tesla in his laboratory, perhaps contemplating his next brilliant invention.

THE TREACHEROUS TOOTHPICK FISH

If you urinate in the Amazon River, a small fish may exact a cringe-inducing revenge

The vast freshwater ecosystem of the Amazon River is home to abundant animal life, and many of its species thrive by virtue of their ferocity. If one were to ask the locals which of the river's indigenous species is the most treacherous, a few might describe the roaming packs of carnivorous piranhas or the massive anaconda snakes, but based on the general sentiment of the region, the most frequently uttered response would most likely be: "candirú."



The candirú is a tiny catfish that dwells in the depths of the Amazon River. These fish do not hunt in packs like the piranha, nor are they exceptionally large like the anaconda. In fact, the candirú is among the tiniest vertebrates on the planet, and it is sometimes referred to as the "toothpick fish" due to its small size and slender shape. Only a handful of people have had the misfortune of crossing paths with the candirú, but their experiences serve as cautionary tales to any who venture into the mighty river.

Though the candirú is a parasite, humans are not among its viable hosts. It lingers in the murky darkness at the river's bottom, quietly stalking fellow fish. Light is scarce in the soupy deep, but the candirú does not need to see . . . it can taste the traces of urea and ammonia expelled from the gills when a fish breathes.

The tiny hunter shadows its prey and is almost invisible due to its slender translucent body. When the target fish opens its gills to exhale, the candirú detects the resulting flow of water and makes a dash for the exposed gill cavity with remarkable speed. Within less than a second it penetrates the gill and wriggles its way into place, erecting an umbrella-like array of spines to secure its position.

As the new host thrashes in panic and pain, the firmly anchored parasite nibbles a hole in a nearby artery with its needlelike teeth and feasts upon the bounty that gushes forth. Within two minutes, the candirú's belly is swollen with the blood of its victim and it retracts its gripping barbs. Though it may seem that the exploited host fish has escaped,

■ *Eel-like, candirú have small heads and slender bodies.*

its profusely bleeding injuries are so extensive that chances of survival are grim. Meanwhile the victorious attacker slinks back into the river's dark places to digest its meal.

There are many troubling stories regarding human run-ins with the candirú, though until recent years these were not given much credence by the medical community. It is not uncommon for a person swimming or bathing in the river to urinate in the water, creating tiny water currents that are rich in urea and ammonia. The tiny, slender catfish cannot always distinguish a urinating human from an exhaling fish gill, and on occasion it will attempt its trademark high-speed attack on some unfortunate soul.

Silvio Barbossa is one such person. He was swimming in the Amazon River when he went head to head with the tiny parasite:

• I felt like urinating. I stood up, and it was then it attacked me . . . When I saw it, I was terrified. I grabbed it quickly so it couldn't go deeper inside. I could only see the end of its tail flapping. I tried to grab it, but it slipped away from me and went in . . . I was very afraid, because the candirú bites.⁹⁹

When the candirú successfully invades a human, it proceeds exactly as it would with a fish host. After entering the orifice, it quickly wriggles its way in as far as possible, often accompanied by the victim's frantic attempts to grip the slippery, mucus-coated tail. In the unlikely event that the panicked victim manages to grasp the fish, its backward-pointing barbs would cause excruciating pain at each pull and bring a quick end to the dramatic tug-of-war. Once inside, the parasite inches its way up the urethra to the near-

est blood-gorged membrane, extends its spines into the surrounding tissue, and starts feasting.

For the candirú, this misguided journey is a one-way trip; its bloody banquet leaves it too swollen to escape. The only known retaliation against the invader is delicate and expensive surgery or, failing that, a folk remedy that combines two herbs to very slowly kill and dissolve the fish. Silvio was fortunate enough to have access to modern medical facilities, though he had to endure three days of profound agony before the fish was extracted by an awestruck urogenital surgeon.

In the unlikely event that the panicked victim manages to grasp the fish, its backward-pointing barbs would cause excruciating pain at each pull.

Silvio's incident was the first officially confirmed report of a candirú attacking a human, but such leg-crossingly horrific tales have haunted the region for generations. According to legend, many men chose penectomy as an alternative to a slow, excruciating death back before surgery was an option.

Though such brushes with the candirú are exceedingly rare in statistical terms, it is wise to heed the advice of the locals and avoid urinating in the river at all costs. When the natives of the Amazon speak, one would be foolish not to listen. They are privy to some of the world's most horrible truths.

THE TREE OF TÉNÉRÉ

A tenacious tree serves as a desert landmark for hundreds of years

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ecause trees are so abundant, it is rare for a single one to be well-known. Some trees become distinguished due to their historical significance.

The Bodhi Tree in India, for example, is where Buddha is thought to have gained enlightenment, and the Liberty Tree in 18th-century Boston was a gathering place for American colonists who objected to British rule.

A few trees are also worthy of note as record-holders. California is home to several such trees: the tallest living tree, a 155.5-meter redwood called Hyperion; the largest, the 1,450-cubic-meter giant sequoia named General Sherman; and the oldest living tree, a 4,800-year-old bristlecone pine known as Methuselah. Meanwhile, a self-regenerating Norway spruce in Sweden boasts the world's oldest root system at 9,000 years.

It's difficult to be certain which individual tree can be called the most remote. For several decades that distinction belonged to the Tree of Ténéré, an acacia tree standing alone in the vast, hostile expanse of the Sahara Desert. However, in 1973 that tree met an exceedingly improbable end.

Also referred to by the French name "arbre du Ténéré," it was the last remnant of what was once part of a sizable forest. Gradual climate change reduced the area to an arid desert and the forest



■ *The Tree of Ténéré, as it stood in the early 1970s.*

Workers discovered that the tree's root system was drawing water from a source over 100 feet underground.

perished; with little vegetation and an average annual rainfall of only 2.5 centimeters, the Ténéré region became very inhospitable. Water became scarce even underground. By the early 20th century, a small group of the thorned, yellow-flowered acacias were all that remained of the trees of the Ténéré. Over time virtually all of them died, leaving only one surviving tree within a 400-kilometer radius.

As a result, the three-meter-tall tree was one of the few interruptions in a vast, empty landscape of sand. Because it was visible from a considerable distance, it became a landmark for desert travelers. Its ability to survive on an unforgiving patch of sand was a mystery at first, but intrepid passersby reasoned that there *must* be a water source. During the winter of 1938–1939, the French military coordinated the digging of a nearby well to increase the utility of the site. Workers discovered that the tree's root



■ *A monument to the fallen original.*

system was drawing water from a source over 100 feet underground. Sometime around the construction of the well, a truck at the site backed into the tree and broke off one of the main branches. The tree managed to survive the impact, though its previously distinct Y shape was lost.

In the decades that followed, caravans shipping grain, salt, and dates across the Sahara often stopped to take water from this well. The tree was so essential to locals' navigation of the large, barren desert that damaging it was inconceivable. As Michel Lesourd

of the Central Service of Saharan Affairs wrote after seeing the tree in 1939, "[t]he acacia has become a living lighthouse." It appeared on large-scale maps of the desert as one of the sole reference points.

By the 1970s many of the passing caravans were trucks rather than camels. In 1973 one such truck was being driven by an allegedly drunk Libyan and, despite the flat, wide-open expanse of the Sahara, he managed to lose control of his vehicle. The truck veered off the road and collided with the only tree in the entire region. This unbelievable second vehicular impact was more than the solitary Tree of Ténéré could bear, and it

snapped from its trunk. It was an estimated 300 years old at the time of its demise.

In November that year the remains of the legendary tree were retrieved and transported to the Niger National Museum in the capital of Niamey, where its dried husk still resides today. At the Tree of Ténéré's original location, an anonymous artist constructed a metal monument made of recycled pipes, fuel barrels, and discarded auto parts. Thus the location remains a landmark—at least until the next drunken truck-driver comes trundling by.

TSAR BOMBA: THE WORLD'S MOST MASSIVE WEAPON

How the Soviets created and detonated the mother of all nuclear bombs

By October 1961, the USSR and the United States were hip-deep in the Cold War, participating in a fierce battle of propaganda and weapons one-upsmanship. Both nations maintained massive stockpiles of nuclear weapons and constantly labored to upgrade the destructiveness of their designs. Many military leaders in the United States were of the outspoken opinion that a nuclear conflict with the Soviets was inevitable and that the U.S. should attack while they still possessed a nuclear advantage.

The Americans held the record for the largest bomb ever detonated: the Castle Bravo test shot at the Pacific Proving Grounds. The American's monstrous thermonuclear hydrogen bomb had created a 15-megaton explosion, the equivalent of 15,000,000 tonnes of TNT. The Soviets aimed to break this record to demonstrate their atomic superiority. In July 1961, Russian scientists began to assemble the most destructive explosive device ever conceived by man. Their colossal bomb was code-named "Big Ivan," and it later came to be known as "Tsar Bomba," or King of Bombs.

To ensure that the bomb test would coincide with an important gathering of Communist leaders, the Russian weapons engineers were allotted a mere 16 weeks to produce a bomb that could outdo the



■ *Tsar Bomba released 3,800 times more explosive energy than the atomic bomb dropped on Hiroshima.*

capitalist pigs' Castle Bravo shot. This aggressive timetable ruled out the fabrication of new parts, so the bomb builders were limited to assembling the Frankenstein weapon using "off-the-shelf" nuclear weapon components. They were also forced to skip much of the mathematical analysis, relying instead on best-guesses and estimations.

OVERKILL OVER BIKINI ATOLL

On March 1, 1954, a blinding flash permeated the sky over Bikini Atoll; the United States had just detonated what was then the most powerful bomb in history. Code-named *Castle Bravo*, the dry fuel thermonuclear hydrogen bomb sent a mushroom cloud 47,000 feet into the sky. A fireball nearly four and a half miles wide vaporized a neighboring island and shot radioactive material as far as Australia and Japan. But it was never supposed to happen this way.

The scientists failed to accurately assess the power of the lithium-7 isotope involved in the reaction, resulting in an explosion of twice the intended magnitude. The 15-megaton weapon was 1,000 times more powerful than the atomic bombs dropped on Hiroshima and Nagasaki. Hundreds of people unsuspectingly caught within the blast suffered severe radiation exposure.

The 23 fishermen who manned the Japanese fishing boat *Lucky Dragon No. 5* were among the most seriously harmed by the accident. Knowing nothing of the bomb resting on a nearby artificial island, they suffered burns and crippling radiation poisoning. One of the men, staring at the apocalyptic sight, screamed, "It's larger than the sun!" To this day, the test remains the most devastating radiological disaster ever caused by the United States.

Despite a flurry of last-minute design changes and uncertainties regarding the weapon's yield, Tsar Bomba was completed and delivered on schedule. The multistage hydrogen bomb weighed 27 metric tons and was roughly the size of a bus. Though it was technically "aircraft-deliverable," it was too large to fit inside the bomb bay of the largest soviet bomber of that era, the Tu-95. Consequently, a bomber was specially modified for the task. The plane's bomb bay doors were removed to allow the bomb to protrude from the plane, and a coating of a special reflective paint was applied to minimize the heat damage it would sustain from the fireball. Big Ivan was also attached to a parachute to prevent it from descending too rapidly, thereby giving the bomber adequate time to get out of range of the blast.

Doubts and uncertainties notwithstanding, on October 30, 1961, the modified Tu-95 dropped Tsar Bomba from an altitude of 34,500 feet over the Mityushikha Bay Nuclear Testing Range in the Arctic Sea. At 11:32 A.M., after a little over three minutes of parachute-slowed descent, the bomb was detonated by the onboard barometric trigger, 13,000 feet above the island of Nóraya Zemly.

The mushroom cloud that followed the blast was enormous. It stretched 40 miles into the sky, and had a diameter of about 25 miles.

The blast was nothing short of spectacular. Despite the cloudy weather, the flash of light was visible as far as 1,000 kilometers distant, though the sound of the blast would not reach that far for 49 minutes, in the form of an indistinct, heavy thud. The giant fireball reached from ground-level to about 34,000 feet into the air, releasing 3,800 times more explosive energy than the Hiroshima bomb—equivalent to 57,000,000 tonnes of TNT. Sixty miles from ground zero the heat would have inflicted third-degree burns on any bystanders. Atmospheric focusing produced areas of destruction hundreds of miles from ground zero, including wooden structures that were completely destroyed and some shattered windows in Finland. The explo-

sion's atmospheric shockwave traveled around the Earth three times before it dissipated.

The mushroom cloud that followed the blast was enormous. It stretched 40 miles into the sky, and had a diameter of about 25 miles. Ionization from the explosion disrupted radio communications for the better part of an hour.

The Soviet scientists had succeeded in besting the Americans, demonstrating a nuclear bomb over three times more powerful than Castle Bravo. Incredibly, the Russian engineers had deliberately crippled their weapon before it was deployed. It was designed to produce a 100-megaton explosion, but the scientists worried that the radioactive fallout would be too dangerous to their homeland. Moreover, the release plane would not have been able to reach safety before detonation. The decision was made to replace a portion of the radioactive uranium with lead, cutting its explosive potential to a mere 57 megatons. Later analysis showed that the fallout from a full 100-megaton detonation would

have resulted in lethal levels of radioactive fallout over an enormous swath of land.

Some time after the explosion, a Soviet team was dispatched to the island of Novaya Zemly at ground zero to take photographs. One witness reported:

“The ground surface of the island has been leveled, swept, and licked so that it looks like a skating rink. The same goes for rocks. The snow has melted and their sides and edges are shiny. There is not a trace of unevenness in the ground . . . Everything in this area has been swept clean, scoured, melted, and blown away.”

Analysis of the explosion indicated an area of absolute destruction over 30 miles wide, and a zone of substantial damage more than 100 miles wide.

Naturally, the United States was outraged at the impertinence of the Russians. The U.S. government was quick to respond by rattling its own nuclear saber in the form of an extensive series of nuclear

weapons tests. Despite Big Ivan's monumental potency, however, the bomb was nothing more than a propaganda piece. Even at half strength, the weapon was so powerful that it was completely impractical. Much of the explosion's energy radiated upward into space, and the explosive force was so excessive that using the device on any European targets would have resulted in adverse effects on Russian interests. Furthermore, its bulk would have prevented it from reaching any North American targets undetected. But as a display of raw force and technical expertise, it served its purpose well. Fortunately for us all, no other weapon even approaching the massive destructive power of Tsar Bomba has ever been built . . . yet.



■ The astonishing result of America's record setting nuclear efforts: the Castle-Bravo mushroom cloud.

THE TUSKEGEE SYPHILIS STUDY

"We have no further interest in these patients until they die"

Early in the 20th century, the medical community was practically helpless in its battle against syphilis. The crippling affliction was spreading at an alarming rate in certain areas, particularly among the poor. Even for those who could afford medical care, the only known treatments rivaled the disease itself in the harm they did to sufferers.

In 1932, Dr. Taliaferro Clark from the United States Public Health Service (PHS) launched a study in Macon County, Alabama, to document the progression of this troublesome sexually transmitted disease. The region was home to hundreds of poor and mostly illiterate black farmers, and cases of syphilis had reached alarming proportions. The Tuskegee Syphilis Study was undertaken in the hopes that a deeper understanding of the affliction would provide new insights on potential treatments and possibly justify a government-funded treatment program. But from these noble beginnings, a lack of funds and a shortage of ethics led to one of the most shameful clinical mishaps in U.S. history.

Syphilis is caused by the bacterium *Treponema pallidum*, and it is among the more dangerous sexually transmitted diseases due to the serious health problems it can cause if left untreated. In its early phases it produces painless sores and rashes along with general feelings of discomfort such as headaches and sore throat. After about a year of such mild symptoms, many patients seem to return to normal health. This stage represents the disease's latency phase, where the infecting bacteria lie in wait within their host for anywhere from a few months to several decades.

When the tertiary stage of syphilis finally strikes, the sufferer's body becomes plagued with a myriad of mysterious, gummy tumors on various parts of the body, and serious damage may begin to occur to the heart, bones, and joints. The disease may also infect the nervous system, a type known as neurosyphilis. This variety can result in damage to the eyes and ears, personality changes, hyperactive reflexes, paralysis, and insanity.

The Tuskegee Syphilis Study was launched in cooperation with the hospital at the Tuskegee Institute, a black university founded by Booker T. Washington. The PHS provided the residents with few details of the study's purpose, but it offered a daily meal and free medical treatment to participants, as well as a \$50 burial stipend for any who agreed to allow an autopsy in the event of their death. To the men who labored in the fields every day and paid rent on the land with a share of their crops, this offer was extremely appealing. Six hundred volunteers were accepted for the study, including 201 healthy men in the control group and 399 who tested positive for syphilis.

Since there were no funds for useful medication for the participants, the investigators could do little more than observe the natural progression of the

disease. The researchers reasoned that as long as they did no harm to the patients, their study was justified by the knowledge it would produce for all of humankind. Almost immediately, however, these noble goals buckled under the weight of misguided research. The doctors opted not to disclose the seriousness of the affliction to volunteers, instead informing them that they required treatment for an ambiguous ailment they referred to as "bad blood."



■ The "golden needle" treatment.

Researchers then provided the volunteers with daily doses of aspirin and iron supplements, which they misrepresented as more useful medication.

These deceptive practices prompted Dr. Taliaferro Clark to retire from the project shortly after the study began, but the remaining researchers continued. Under the care of nurse Eunice Rivers—a black nurse who had trained at Tuskegee—blood samples were periodically taken from participants. They were also subjected to occasional spinal taps, a test where the spinal column is punctured by a large needle to collect a sample of cerebrospinal fluid. This "golden needle treatment" offered no health benefits, and in fact it often triggered severe

headaches and nausea, and there was even a small risk of disability or death. The researchers deemed it necessary in order to test for indications of neurosyphilis. Patients received letters offering "special free treatment" to coax them into agreeing to the tests. The procedure was usually administered for an entire region in one day in order to prevent word of its unpleasantness from discouraging participation.

Despite the occasional discomfort, patients were delighted to be receiving medical attention from the government. Many of the syphilis sufferers brought baked goods for the doctors as a way of showing gratitude.

During the early years of the study, the medical community's only weapons against syphilis were toxic cocktails laced with mercury or arsenic, which were sometimes more harmful than the disease itself. Some creative practitioners had tried deliberately infecting patients with malaria to produce a prolonged fever that would sometimes kill the syphilis infection, following

up with an effective antimalaria treatment known as quinine. In the mid-1940s, however, the recently discovered antibiotic penicillin was determined to be a safe and effective cure for syphilis, and the U.S. government sponsored a nationwide public health program in an effort to eradicate the disease.

The researchers at Tuskegee, in a bid to preserve the fruits of their labors, kept the cure a secret from their subjects. They also supplied local doctors with lists of the participants' names and instructed the physicians not to provide penicillin lest they interfere with a government health study. The administrators of the experiment were not interested in saving the lives of the black farmers; they were

HER CELLS LIVE ON . . .

Henrietta Lacks lived in Maryland, mothered five children, and at the age of 31 she died. Her unfortunate demise was the result of cervical cancer. Although it claimed her life in October 1951, her cancer still lives today.

As a matter of procedure, her cancer was harvested and cells cultured. Soon a remarkable quality of the cells was noticed: Unlike all other human cells, each of these could split an infinite number of times, and each offspring was a perfect copy of the parent. A hospital resident named George Gey began distributing the cells as a means to research cancer. The cells were invaluable in that respect, but they proved difficult to handle because they grew at such a phenomenal rate and they had a tendency to find their way into other sample dishes.

Initially, Henrietta's name was concealed. The cancer cells were labeled as having come from "Helen Lane," hence the cells received the name "HeLa Cells." Even today most cancer research facilities worldwide have some HeLa Cells on hand.

Despite the fact that these cells have been heroic to the causes of cancer and age research, they are not without controversy. Neither Henrietta nor her family had consented to the use of her extraordinary tumors for medical research, and some suspect that the hospital had opted to exploit her tissues without permission because Henrietta was a black woman.

Though no one has gone to the trouble to measure, it is speculated that the volume of HeLa Cells in the world today far outweighs the woman from which they originally came.

interested only in dissecting them on an autopsy table. As one of the doctors unceremoniously stated, "We have no further interest in these patients until they die."

Of the 399 original infected volunteers, only 74 survived to learn that their doctors had only been pretending to treat their disease for the past four decades.

After the end of the Second World War, revulsion over the Nazis' unnecessary human experiments prompted the Counsel for War Crimes to establish the Nuremberg Code. This set of principles defined the boundaries of human experimentation and

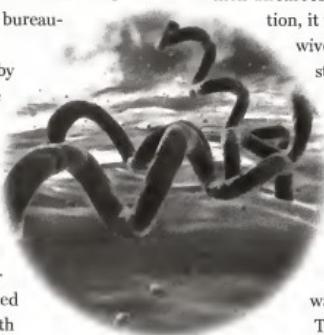
established the requirement for informed consent. The Tuskegee study was clearly in direct violation of many of these guidelines, yet the experiments continued without interruption. For years the doctors in Macon County treated their patients with a regimen of placebos as the men's health degenerated under the ravages of untreated syphilis. The autopsies revealed a wide range of syphilis complications, including leaky heart valves, burst aortas, skeletal tumors, degenerated spinal cords, and brain damage.

In 1966, a venereal disease investigator working for the PHS named Peter Buxton learned of the study and sent a letter to his department director expressing his moral concerns regarding the experiment. The U.S. Centers for Disease Control (CDC) responded by asserting that the study must continue until all of the patients had died, allowing the researchers the opportunity to autopsy all of

the patients. This conclusion was supported by the National Medical Association and the American Medical Association. Nonetheless, Buxton continued his efforts to bring attention to the questionable ethics of the study, but his words failed to penetrate the tangled mass of bureaucracy and racism at the CDC.

On July 25, 1972, an article by Jean Hellerv appeared in the *Washington Star* newspaper condemning the Tuskegee study and its practices. It was written in response to a letter sent by Buxton that outlined the travesties of the ongoing research. The newspaper's readers were horrified to learn that the Public Health Service was deliberately preventing the test subjects from receiving treatment. The story appeared on the front page of *The New York Times* the following day. The government defended its long-term study, pointing out that the experiments were carried out on volunteers and that the patients were always happy to see their doctors. But the weight of public disapproval crushed the feeble excuses, and an ad hoc advisory panel was assembled that quickly condemned the study and ordered its termination.

When the study ended, it had been 40 years since the doctors administered their first placebo treatment for "bad blood" in Tuskegee. Over the course of the study, 28 of the men had died of syphilis, and 100 were dead due to related complica-



■ *Treponema pallidum, the bacteria behind syphilis.*

tions. Many of these patients died after penicillin had become readily available. Of the 399 original infected volunteers, only 74 survived to learn that their doctors had only been pretending to treat their disease for the past four decades. In addition, it was found that 40 of the men's wives had been infected during the study, and 19 of their children had been born with congenital syphilis.

The following year the National Association for the Advancement of Colored People (NAACP) won a \$9 million settlement on behalf of the victims, and the sum was divided among the survivors. They and their families were also guaranteed free medical care for the rest of their lives.

Few of the researchers who participated in the study ever admitted to any lapse in ethics, most of them insisting that they were merely following the directions of their superiors. This hollow defense is eerily reminiscent of the explanation offered by the Nazi experimenters in Nuremberg, with whom the Tuskegee researchers have been compared unfavorably on many occasions. The Nazi scientists also claimed that they were "just following orders," a condition that seems to disabuse ordinary people of their personal morals. Not even Eunice Rivers—the black nurse who was a vital part of the study for its entire 40-year span—felt that anything unethical had transpired.

UNANTICIPATED SIDE EFFECTS



The law of unintended pharmaceutical consequences

When one is stricken with an irritating or socially unacceptable malady, modern medicine offers a plethora of pills to restore relative normality. But the temperamental chemicals occasionally replace the disease with unsettling side effects. Here are but a handful:



"I CAN'T STOP YAWNING" Users of the antidepressant clomipramine (brand name Anafranil) may experience a parade of unpleasantness including dry mouth, anxiety, and seizures. But approximately 1 in every 20 prescribers describe a very curious and stimulating side effect: They experience an orgasm whenever they yawn. This occurs even when the yawn is deliberate. Needless to say, patients should practice caution when operating heavy machinery.

TRUST SERUM The hormone oxytocin is used to induce labor and/or assist in difficult deliveries, and it is sometimes prescribed to assist a mother in breastfeeding her new infant. Strangely, studies have also shown that the medication greatly increases one's tendency to trust others and it makes a person considerably more generous.

LOSE WEIGHT, LOSE FRIENDS The weight-loss drug Orlistat (marketed under the brand names Xenical and Alli) can indeed help one reduce weight by preventing the absorption of dietary fat. Unfortunately the undigested fats require one to anticipate "changes in bowel habits," including increased flatulence (often with oily discharge), an increased number of bowel movements, an urgent need to have them, and an inability to control them. To help cope with this profound bowel distress, some manufacturers suggest that users wear dark pants and keep spare clothes handy until they develop a sense of their "treatment effects."

TOO MUCH OF A GOOD THING Sildenafil citrate, an erectile-dysfunction treatment more popularly known as Viagra, has been known to trigger a few scattered episodes of priapism. This prolonged, painful erection can last for hours and is considered a medical emergency since it can cause long-term damage to the penis. In the most extreme cases, gangrene can set in and a penectomy may be required.



RESTLESS BEHAVIOR The medication Ropinirole (sold under the brand names Requip and Ropark) provides some relief for sufferers of Parkinson's disease and Restless Leg Syndrome (RLS), but it has also been implicated in causing compulsive behavior such as excessive gambling, unnecessary shopping sprees, and addiction to sexual activity. Mirapex—another drug used to treat Parkinson's and RLS—has been known to trigger amnesia in some users, causing them to forget what they did during certain hours or days.

BLUE IN THE FACE Colloidal silver is a popular alternative medicine that is credited by quacks as a cure for a gamut of ills, including cancer, infectious diseases, parasites, fatigue, acne, and hemorrhoids. It is essentially a suspension of microscopic metallic silver particles in a liquid base. When an individual ingests too much colloidal silver over time, the silver salts can concentrate in the skin and turn the individual's skin an ashen blue. The condition is known as *argyria*. Although silver has been shown to have some mild antibacterial properties, the U.S. Food and Drug Administration (FDA) does not recognize it as safe or effective for medical ailments.

URINE SPECTRUM Certain medications have been known to alter the color of patients' urine, undoubtedly resulting in many anxious and embarrassed telephone calls to physicians.

- Orange urine can come about when one takes the antibiotic Rifampin; the blood thinner Coumadin; or a treatment for urinary tract discomfort known as Pyridium. The herbal laxative Senna can also lend an orange tint to one's urinary emissions.
- Red urine can arise in people taking the antipsychotic drug Thorazine or the anesthetic agent Diprivan.
- Green urine can appear when a doctor prescribes Elavil to treat depression and/or bed-wetting; or when Robaxin is administered to treat muscle spasms.
- Blue pee is surprisingly common, caused by such medications as Dyrenium (a diuretic), Indocin (antiinflammatory), Tagamet (antacid), and Phenergan (anti-nausea).
- Purple pee has occasionally been blamed on the laxative agent phenolphthalein.
- Brown or "tea-colored" urine can be caused by antimalaria drugs Chloroquine and Primaquine; the antibiotic Metronidazole; the muscle relaxant Methocarbamol; and a urinary tract infection treatment known as Nitrofurantoin.
- Black urine has made some harmless but unsettling appearances among users of antibiotics such as Flagyl and Furazolidone; another known culprit is Aldomet, a drug used to treat high blood pressure in pregnant women which also happens to cause one's urine to turn black when it comes in contact with common toilet bowl cleaners.





UNDARK AND THE RADIUM GIRLS

Radioactive factories and the villains who owned them

In 1922, a bank teller named Grace Fryer became concerned when her teeth began to loosen and fall out for no discernible reason.

Her troubles were compounded when her jaw became swollen and inflamed, so she sought the assistance of a physician. Using a primitive X-ray machine, the doctor discovered serious bone decay, the likes of which he had never seen. Her jawbone was honeycombed with small holes, in a random pattern reminiscent of moth-eaten fabric.

As a series of doctors attempted to explain Grace's mysterious ailment, similar cases began to appear throughout her hometown of Orange, New Jersey. One dentist in particular took notice of the unusually high number of deteriorated jawbones among local women, and it took very little investigation to discover a common thread; all of the women had been employed by the same New Jersey watch-painting factory at one time or another: the U.S. Radium Corporation.

In 1902, 20 years prior to Grace's mysterious ailment, inventor William J. Hammer left Paris with a curious souvenir. The famous scientists Pierre and Marie Curie had provided him with some samples of their radium salt crystals. Radioactivity was somewhat new to science, so its properties and dangers were not well understood; but the radium's slight blue-green glow and natural warmth made it fascinating. Hammer combined his radium salt with glue and a compound called zinc sulfide, which glows in the presence of radiation, thereby producing a very nifty and marketable glow-in-the-dark paint.

The U.S. Radium Corporation used Hammer's recipe to produce Undark, a high-tech paint that allowed America's World War I infantrymen to read their wristwatches and instrument panels at night. They also marketed the pigment for non-military products such as house numbers, pistol sights, light switch plates, and glowing eyes for toy dolls. By this time the dangers of radium were better understood, but U.S. Radium assured the public that its paint used the radioactive element in "such minute quantities that it is absolutely harmless." While this was true of the products themselves, the amount of radium present in the factory was much more dangerous, unbeknownst to the workers there.

U.S. Radium employed hundreds of women at its factory in New Jersey, including Grace Fryer. Few companies at that time were willing to employ women, and the pay was much higher than most alternatives, so the company had little trouble finding employees to occupy the rows upon rows of desks. Their task was to paint delicate lines with fine-tipped brushes, applying the Undark to the

tiny numbers and indicator hands of wristwatches. After a few strokes a brush tended to lose its shape, so the women's managers encouraged them to use their lips and tongues to keep the tips of the camel-hair brushes sharp and clean. The glowing paint was completely flavorless, and the supervisors assured them that "rosy cheeks" would be the only physical side effect to swallowing the radium-laced pigment. Cause for concern was further reduced by the fact that radium was being marketed elsewhere as a medical elixir for treating all manner of ailments.

The owners and scientists at U.S. Radium, familiar with the actual hazards of radioactivity, took extensive precautions to protect themselves.

They knew that Undark's key ingredient was approximately one million times more active than uranium, so company chemists often used lead screens, masks, and tongs when working with the paint. U.S. Radium had even distributed literature to the medical community describing the "injurious effects" of radium. But inside the factory, where nearly every surface sparkled with radioluminescence, these dangers were obscured. For a lark, some of the women even painted their fingernails and teeth with radium paint on occasion—to surprise their boyfriends and husbands when the lights went out.

In 1925, three years after Grace's health problems began, a doctor suggested that her jaw problems



■ *The Undark girls hard at work assembling nuclear timepieces.*

may have had something to do with her former job at U.S. Radium. As she began to explore the possibility, a specialist from Columbia University named Frederick Flynn asked to examine her. Flynn declared her to be in fine health. It would be some time before anyone discovered that Flynn was not a doctor, nor was he licensed to practice medicine; rather he was a toxicologist on the U.S. Radium payroll. A "colleague" who had been present during the examination—and who had confirmed the healthy diagnosis—turned out to be one of the vice presidents of U.S. Radium. Many of the Undark painters had been developing serious bone-related problems, particularly in the jaw, and the company had begun a concerted effort to conceal the cause of the disease. The mysterious deaths were often blamed on sexually transmitted diseases such as syphilis to undermine the women's reputations. Many doctors and dentists inexplicably cooperated with the powerful company's disinformation campaign.

In the early 1920s, U.S. Radium hired the Harvard physiology professor Cecil Drinker to study the working conditions in the factory. Drinker's report was grave, indicating a heavily contaminated workforce and unusual blood conditions in virtually everyone who worked there. The report, which the company provided to the New Jersey Department of Labor, credited Cecil Drinker as the author. However, the ominous descriptions of unhealthy conditions were replaced with glowing praise, stating that "every girl is in perfect condition." U.S. Radium's president disregarded all of the advice in Drinker's original report, making none of the recommended changes to protect the workers.

The fraudulent report was noticed by Alice Hamilton, a colleague of Drinker's who was familiar with his actual findings. In 1925, she wrote a letter to Drinker, prompting him to make the information public by publishing his original report in a scientific journal. U.S. Radium executives were furious and threatened legal action, but Drinker

published his findings nonetheless. Among other things, his report stated:

"Dust samples collected in the workroom from various locations and from chairs not used by the workers were all luminous in the dark room. Their hair, faces, hands, arms, necks, the dresses, the underclothes, even the corsets of the dial painters were luminous. One of the girls showed luminous spots on her legs and thighs. The back of another was luminous almost to the waist."

U.S. Radium was a defense contractor with deep pockets and influential contacts, so it took Grace Fryer two years to find a lawyer willing to confront her former employer in court. A young attorney from Newark named Raymond Berry finally took the case in 1927, and four other radium-injured dial painters soon joined in the suit. They sought \$250,000 each in damages.

As the legal battle ensued, New York dentist Joseph P. Knef examined the jawbone from one of the deceased dial painters named Amelia Maggia. In the last few months of her life the bone had become so decayed that Dr. Knef had been forced to remove it from his patient. Her official cause of death had been listed as syphilis, but Knef suspected otherwise. He wrapped the jawbone in dental X-ray film, let it sit a while, and then developed it. Patterns on the film indicated an extraordinarily high level of radiation emanating from the bone, and he confirmed the findings with an electroscope.

As the weeks and months were consumed by the slow-moving court system, the women's health rapidly deteriorated. At their first appearance in court in January 1928, two were bedridden, and none could raise their arms to take the oath. Grace Fryer, still described by reporters as "pretty," was unable to walk, required a back brace to sit up, and had lost all of her teeth. The "Radium Girls" began appearing in headlines nationwide, and the grim descriptions of their hopeless condition reached Marie Curie, a pioneer in the field of radioactivity, in

Paris. "I would be only too happy to give any aid that I could," she said, adding, "There is absolutely no means of destroying the substance once it enters the human body."

The women proved too ill to attend the second hearing, which occurred in April. Despite strenuous objections from the women's lawyer, the judge adjourned the case until September because several U.S. Radium witnesses were summering in Europe and would consequently be unavailable. Walter Lippmann, the editor of the influential *New York World* newspaper, wrote of the judge's decision, calling it a "damnable travesty of justice . . . There is no possible excuse for such a delay. The women are dying. If ever a case called for prompt adjudication, it is the case of five crippled women who are fighting for a few miserable dollars to ease their last days on earth." In a later editorial, he wrote, "This is a heartless proceeding. It is unmanly, unjust and cruel. This is a case which calls not for fine-spun litigation but for simple, quick, direct justice."

Later medical research would determine that radium behaves much like calcium inside the body, causing it to concentrate in the teeth and bones.

The national outrage over the delay prompted the courts to reschedule the hearing for early June. Days before the trial, Raymond Berry and U.S. Radium agreed to allow U.S. District Court Judge William Clark to mediate an out-of-court settlement. Berry and the Radium Girls accepted their opponent's offer reluctantly, despite learning that Judge Clark was a U.S. Radium Corporation stockholder. Their situation was too desperate to refuse; the women were not expected to live much longer.

Each woman would receive \$10,000—equivalent to about \$100,000 today—and have all of their medical and legal expenses paid. They would also receive a \$600 per year annuity for as long as they lived. Not surprisingly, very few of the annuity payments were collected.

The last of the famous Radium Girls died in the 1930s, and many other former factory workers died of radium poisoning without finding justice. Later medical research would determine that radium behaves much like calcium inside the body, causing it to concentrate in the teeth and bones. By shaping their brushes with their lips as instructed by their supervisors, the dial painters had ingested anywhere from a few hundred to a few thousand microcuries of radium per year. One tenth of a microcurie is now considered to be the maximum safe exposure. Marie Curie herself died of radiation-related ailments in 1934. Because radium has a half-life of 1,600 years, her lab notebooks are said to be too highly contaminated to be safely handled even today. Radium continued to be used to illuminate watches until about 1968, but under much safer conditions.

It is uncertain how many people were sickened or killed by Undark and similar radioactive pigments over the years, but U.S. Radium alone employed an estimated 4,000 radium dial painters. Though they were not the only radium-painting business in the U.S., they were arguably the most malevolent. However, one positive development did appear in the wake of the women's legal struggle and subsequent media attention: In 1949 the U.S. Congress passed a bill making all occupational diseases compensable, and extended the time during which workers could discover illnesses and make a claim. Thanks to the Radium Girls and their success in bringing attention to the deplorable conditions in U.S. factories, industrial safety standards in the U.S. were significantly tightened over the following years, an improvement which definitely spared countless others from similar fates.

UNDEAD HAMSTERS AND THE GAIA THEORY

How reanimating dead hamsters can teach us something about the meaning of life



One afternoon in the early 1950s, a young biochemist left his suburban lab bench at Britain's Mill Hill National Institute of Medical Research and boarded a Tube train to Leicester Square. His destination was nearby Lisle Street, in an area that today makes up part of London's glittering West End theater district.



■ Dr. James Lovelock in his lab.

In the postwar years, the sector was better known as a hectic hub for two of humanity's oldest professions, yet only one of these was of interest to the young scientist. The girls hawking their wares seemed to sense his single-mindedness and kept their distance. This left the greenhorn researcher free to pursue his true quarry: the abundance of second-hand military hardware that could be found in the shops lining Lisle Street. Specifically, he was looking for war-surplus radar equipment. His intention was to cannibalize a suitable radio frequency transmitter in order to reanimate dead, frozen hamsters.

The purposeful young biochemist was working in a field so new that it didn't even have an official name, although eventually the term "cryobiology"—literally meaning "frosty life"—gained currency. One of his colleagues at Mill Hill was Dr. Audrey Smith, the leading light in a series of hamster freezing and reanimation experiments. The dramatic and oft-quoted results have since achieved legendary status among cryobiologists, both of the credible variety and of the we'll-freeze-your-head-and-bring-it-back-to-life-when-future-technology-allows variety.

The basic procedure worked like this:

- 1 Obtain desired number of Golden Hamsters (*Mesocricetus auratus*).
- 2 Place in ice bath at temperature -5°C.
- 3 Leave hapless rodents to cool until hearts have stopped beating, respiration has ceased, animals are frozen rigid and are, by any conventional definition of life, dead.
- 4 After 60 to 90 minutes, remove hamsters from ice bath.
- 5 If required, cut sections of one or more control animals to determine degree of freezing. Please note: Animals thus examined should not be used in subsequent reanimation attempts.
- 6 Warm the hearts of the frozen hamsters until they start up again, followed by gentle rewarming of the rest of the animal(s) until miraculous recovery occurs.
- 7 Determine number of survivors.

Serves 5.

In the initial experiments, reanimation of the hamsters was carried out using the crude method of pressing a hot metal spoon against the animal's chest until circulation resumed. The important thing was to warm the heart first—the researchers had found that simply placing the hamsters in a bath of warm water would lead to an overrapid resumption of circulation, promptly stopping the heart again due to contact with the freezing-cold blood returning from the animals' extremities. By applying heat to the heart first, a more gradual reanimation could take place.

Everyone involved felt that the use of the hot metal spoons was a step too far; the burning and singeing of the skin caused obvious distress to the reanimated animals. The purpose of the visit to Lisle Street was to make this aspect of the rewarming process more comfortable for rodent and human

alike. By adapting an old aircraft radio-frequency transmitter to emit microwaves, a *diathermy* device was made that could heat the hamsters' hearts externally without damaging the skin.

The astute scientist who pioneered this technique, and later braved the whores of Lisle Street to find suitable equipment, was a man named



James Lovelock. In his autobiography *Homage to Gaia*, he describes how his work on hamster-reanimation got him thinking about the meaning of life. According to conventional definitions of "life," the frozen hamsters were decidedly dead; the unfortunate rodents weren't moving, they weren't breathing, their hearts had stopped, and they certainly weren't eating, drinking, or reproducing. Yet they could be made almost as good as new with

a little bit of hot-spoon or microwave therapy. He wondered if "life" might have a broader meaning. Many years later, this led to the theory for which he is most well-known: the Gaia Hypothesis.

Gaia theory proposes the existence of a system of complex feedback mechanisms that work across the whole of the Earth's surface. These involve both living and nonliving parts of the biosphere, acting in concert to keep the chemistry and temperature of the planet comfortable for life. Although Lovelock was careful to stress that his theory wasn't suggesting that the Earth itself was alive—only that the Earth system mimics a living, self-regulating entity in some ways—many scientists struggled with the analogy. It was a difficult concept to reconcile with the traditionalist view that something was alive only if it met certain established criteria, such as being capable of metabolism, growth, or reproduction. For a start, the Earth doesn't eat or move purposefully, and it has never displayed any discernible interest in mating with neighboring planets.

Meanwhile, cryobiology research continued. By the time Lovelock left Mill Hill in the early 1960s, the freezing and successful reanimation of hamsters using microwave diathermy was almost routine. However, there were limitations to the technique. For a start, the temperatures involved never went further than a few degrees below the freezing point of water and only for an hour or so at a time. In some cases, more than 80 percent of the water in the skin and 60 percent of the water in the brain had changed to ice, but the animals were never 100-percent frozen. Thus, most of the hamsters' cells were spared the shattering that is characteristic of full ice crystal formation.

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Regardless of these shortcomings, the results were dramatic, demonstrating that it is possible to lower complex organisms to below-freezing temperatures and then successfully reanimate them. Attempts to repeat the experiments with larger mammals and at lower temperatures have not yet been successful. However, the knowledge gained had clear relevance for improving human health: Current medical advances that derive from early cryobiology research include techniques for the storage and transport of human tissues destined for transplant, and experimental techniques for

improving outcomes in resuscitation after cardiac arrest. Though these researchers were not advocating the freezing of dead human bodies or heads for later reanimation, their research did become the basis for just such a movement—a scandal-tainted offshoot of cryobiology known as cryonics.

Although Smith's team did much of the groundwork, Mill Hill did not have a monopoly on ghoulish cryobiology experiments; related research was carried out elsewhere. A researcher at Japan's Kobe University, Isamu Suda, froze cat brains in solutions containing glycerol for extended periods in the 1960s. When the brains were rewarmed—up to two and a half years later—brainwave activity was recorded in some of the specimens.

These days ethical considerations limit the scope of such research. Animal experiments still take place at Mill Hill, but only under a strict review process that balances any possible benefits of the research against actual or potential suffering to the animals involved. The original hamster freezing experiments were carried out in a spirit of pure research and lacked such exhaustive justifications. In today's climate, such hot-spoon and ice-bath hijinks would be well and truly off-menu.

The potential demonstrated by frozen-hamster research has yet to be fully realized, but perhaps these groundbreaking efforts will lay the foundation for powerful new medical procedures. Indeed, a hot oversized spoon might one day miraculously transform frozen human cadavers back into living, breathing, productive zombies to slave away in the mechanized underworld of the future. Until that long-hoped-for day arrives, perhaps—like James Lovelock—we can console ourselves with the idea that this pioneering work has helped broaden the meaning of life.

URINE FOR A TREAT

The debatable benefits of imbibing pee

There is a type of large mushroom called *Amanita muscaria* that grows in some parts of Siberia, and its fungous form contains a cocktail of hallucinogenic chemicals. A person who consumes the sun-dried mushrooms will usually experience euphoria and hallucinations, but they must also weather a host of unpleasant side effects such as nausea, twitching, and a marked increased sweat and saliva output.

Many years ago, the Koryak tribe in Siberia discovered that most of these unwanted side effects can be avoided by simply putting the mushrooms through a sophisticated filter: a human being. The eater's kidneys remove the chemicals that cause the moist, queasy spasms while leaving the hallucinogenic alkaloids intact. Consequently, it became commonplace to collect the urine of a mushroom-eater for use as an intoxicating beverage. The urine drinkers' urine was also valuable since the alkaloids' potency did not decrease significantly until about the seventh time through a man-filter.

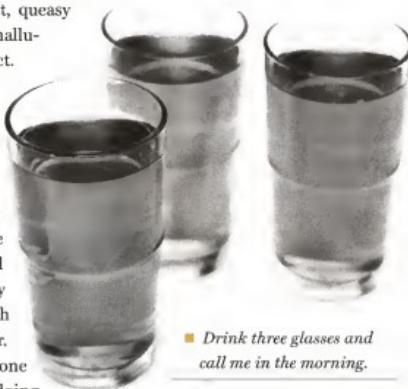
Of course not everyone who imbibes urine is doing so for hallucinogenic pleasure-seeking. There are many who subscribe to the notion that the practice offers a myriad of health benefits, some even hailing "sparkling human cider" as medicinal gold.

Most humans regard their urinary excretions as profoundly unappealing, but proponents of uro-

therapy argue that this repulsion is artificial and unjustified. Indeed, although urine has a reputation as a filthy, germ-ridden fluid, a healthy person's urine is actually quite sterile.

The deliberate drinking of urine is particularly popular in Indian and Chinese cultures for its purported curative properties. In June 2001, a Chinese news service reported that more than three million Chinese people drink their own urine to maintain good health. Around the world, certain very dedicated athletes utilize their own urine as a natural energy drink to replace lost electrolytes.

Pee-based health products have been around for millennia—Aztec physicians administered urine to relieve stomach and intestine problems, ancient writings suggest that the Romans of old used the bleaching power of urine as a teeth whitener, and it was used extensively in the early Middle Ages as



■ Drink three glasses and call me in the morning.

a cure-all. According to some historians, even the ancient Greek "father of medicine" Hippocrates extolled the healing virtues of urine. People who are particularly credulous claim that Proverbs 5:15 is a divine endorsement of urotherapy: "Drink waters out of thine own cistern, and running waters out of thine own well."

When asked for proof, a practitioner of urotherapy can often dribble out centuries' worth of anecdotal evidence. Pee is one of the original snake oils, credited with curing such diverse maladies as irregularity, eczema, food allergies, exhaustion, chronic illness, depression, jaundice, scurvy, gout, ulcers, rheumatism, "hysterical vapors," obesity,

bed-wetting, baldness, broken bones, and much, much more. There is, however, somewhat stronger evidence showing that urotherapy can help relieve pleasant-smelling breath and social popularity.

Devoted drinkers explain that most frequent misconception about urine is that it is a bodily waste product. They insist that it is simply a nontoxic cocktail of vitamins and nutrients that were filtered out by the kidneys because the body didn't have an immediate need for them. By reintroducing these useful substances, the body has another chance to absorb them—or so the argument goes. They also state that the scant traces of waste products are actually helpful, stimulating a cleansing reac-

CANINE CURATIVE?

These days, ethically minded folk take care to ensure that their chosen medicines—be they the urine-tainted variety or more conventional pharmaceuticals—are not tested on furry, photogenic animals such as puppies. Such people might be reassured to know that a 16th-century French battlefield surgeon, Ambroise Paré, did not evaluate his legendary wound salve on such cuddly creatures. Deeper investigation, however, would likely leave them profoundly ill at ease, for the Frenchman's "puppy oil" was not tested on young whelps, but made from them.

Paré spent two years apprenticed to a surgeon in Turin to gain access to a special recipe for making his battlefield balm, which he subsequently popularized far and wide. Two newly born puppies were slowly cooked in "oil of lilies" until the bones dissolved, and the resulting brew was blended with Venetian turpentine and a pound of earthworms. Paré maintained that this concoction soothed pain and encouraged healing when applied to the gunshot wounds of war-weary soldiers. Such a monstrous potion is naturally out of the question in our more enlightened age, but there may yet be untapped medicinal potential in orphan tears and panda-cub paste.



tion in the body to eject assorted toxins. Uropaths suggest a gradual introduction to the natural beverage, starting with two- to three-ounce servings and gradually increasing to one's own "comfortable" level of consumption."

Chemists concur that urine contains many vitamins, hormones, and nutrients that are essential to the proper functioning of the human body. A typical urine sample will include such useful compounds as calcium, iron, magnesium, riboflavin, vitamins B₆ and B₁₂, and zinc. It also contains urokinase, an organic compound proven to prevent heart attacks and strokes by breaking up blood clots. While it is true that some of the constituents of urine have therapeutic properties, it does not follow that drinking one's urine is therapeutic. No formal studies have validated the benefits of urine therapy, though it is highly doubtful that any scientific human trials ever have—or ever will—be made.

One compelling argument against urotherapy—besides the unpleasant taste—is that urine allows dangerous toxins to be reintroduced into the body. Environmental contamination typically introduces traces of toxins like arsenic into a person's diet, and such poisons can become harmfully concentrated in urine. The same can occur with certain drugs, such as the hormones in contraceptives. Urine also comes with a substantial serving of salt, which can lead to dehydration. Generally speaking, it's not a good idea to follow medical advice from the early Middle Ages, an era where few people lived past 45 years of age. Even the Chinese Association of Urine Therapy warns new drinkers that they may begin to experience "diarrhea, itch, pain, fatigue, soreness of the shoulder, fever, etc."

Generally speaking, it's not a good idea to follow medical advice from the early Middle Ages, an era where few people lived past 45 years of age.

According to the true urine-cure zealots, reports of discomfort and/or death among pee-drinkers are the product of a vast conspiracy. Indeed, if it were ever proven that every individual has the ability to squeeze out their very own magical medical elixir each morning, the multibillion-dollar health and pharmaceutical industries would see their profits rapidly peter out.

One scenario where urine can sometimes play a beneficial role is in survival situations, such as avoiding dehydration in the desert or on ships adrift at sea. Urine's sodium content makes it little better than seawater, however, so introducing undiluted urine into an already dehydrated body is not advisable. It can cause kidney damage and may accelerate dehydration through diarrhea and/or vomiting. But urine can prove useful in certain scenarios; for instance, the U.S. Army's Combat Feeding Directorate has spearheaded the development of special dehydrated food packs where urine can, in an emergency, be used to rehydrate pouches of dried chicken and rice.

In spite of the evidence, there are still a surprising number of adherents to urine therapy. Perhaps "Big Medicine" really is suppressing the truth, and we non-urine-drinkers are peeing away our good health. Or perhaps people who are naïve and desperate enough to drink their own drainings are particularly prone to the placebo effect. Under normal circumstances, a person so inclined can drink fresh urine with no ill effects; but given that all of the vitamins and nutrients contained in urine can also be obtained through more conventional means—such as a healthy diet or vitamin supplements—a tall, warm glass of urine is probably not the ideal thirst-quencher. Unless, of course, you just like the taste.



THE USS PUEBLO AND THE HAWAIIAN GOOD LUCK SIGN

Spies captured off the Korean coast introduce the communists to some of the finer points of Western culture

In the winter of 1968, the U.S. Navy electronic surveillance ship *USS Pueblo* was quietly lurking off the east coast of North Korea, its assorted antennae pricked to absorb any kind of interesting electronic transmissions. The North Koreans would certainly cease any intelligence-worthy communications if they learned that the "environmental research" ship was eavesdropping, so the *Pueblo*'s crew operated under radio silence to avoid detection. Nevertheless, there was little for the sophisticated electronics to observe; in terms of signals, the Soviet-friendly Democratic People's Republic of Korea (DPRK) was uncharacteristically quiet. With scant information to pore over, the only interruption to the monotony was the occasional task of chipping the thick frosting of ice from the deck.

But on January 22, something out of the ordinary happened. Two gray fishing trawlers spotted the *Pueblo* and circled her for a time, clearly agitated despite the fact that the U.S. Navy ship was in international waters. There seemed to be little cause for concern, however, since such encounters were not unheard of. The trawlers departed without incident, so Commander Lloyd Bucher reported the episode and continued with his mission. Had the shore-side Navy personnel informed the Commander of recent incidents on the peninsula, he may have reconsidered his decision to remain so close to the edge of DPRK territorial waters.

The previous evening, 31 North Korean operatives had secretly crossed the demilitarized zone

(DMZ) into South Korea. Clad in South Korean military uniforms, the commandos were within a block of their target—the Presidential Palace—before being detected. In the ensuing gunfight, 29 of the would-be assassins were killed and one committed suicide. The single surviving prisoner was taken in for questioning, where he revealed that his mission had been to murder South Korea's President Park and other senior government officials.

Unaware of the troubles onshore, the *Pueblo* began what was scheduled to be the final day of monitoring. The morning was uneventful, but the crew's lunch was interrupted by a report of a North Korean warship approaching at high speed. The patrol vessel advanced at 40 knots, and as it



■ The captive crew of the USS Pueblo subtly display the "Hawaiian good luck" sign.

drew near it raised signal flags to demand that the *Pueblo* identify its nationality. The crew grew uneasy as they realized that the intercepting vessel was at battle stations. Commander Bucher verified by radar that his ship was indeed farther than 12 nautical miles from shore and therefore in international waters. The crew hoisted the American flag in response as three torpedo boats were spotted approaching from the coast.

The ensuing signal-flag conversation led to an alarming message from the DPRK patrol boat: HEAVE TO OR I WILL FIRE. Two MiG fighters buzzed the *Pueblo*, and two additional warships were sighted on the horizon, approaching fast. Bucher gave orders to make for the open sea. As a torpedo boat attempted to pull alongside, *Pueblo*'s pilot maneuvered the ship to prevent an armed group of soldiers from boarding. Retreat was the crew's only option; her weapons were sealed under a thick layer of winter ice. In response to her distress call, the Naval Security Group in Japan prom-

ised to send fighters. The *Pueblo* vainly attempted to outrun the smaller, faster warships, but the DPRK ships gave chase and opened fire.

A hail of 57-mm explosive rounds peppered the U.S. Navy ship, and one of the pursuers opened her torpedo tubes. Commander Bucher accepted the hopelessness of escape and gave the order to begin destroying all sensitive documents and equipment. The ship came to a halt as crew members frantically loaded the incinerator with documents, threw materials over the side, and smashed equipment with hammers. The task was daunting, however, as the spy vessel had been furnished with a great deal of highly sensitive materials. To prevent further attacks, Commander Bucher complied with the attacker's signal to follow them back toward the shore.

Just outside of Korean territorial waters, the *Pueblo* shut down her engines. The DPRK vessels once again opened fire. Seaman Duane Hodges was mortally wounded in the attack, and several others were injured as they stood on the deck

flinging classified materials into the sea. Unable to respond to the aggression with due violence, Commander Bucher had no choice but to order that they continue. Shortly after leaving international waters, the *Pueblo* was boarded. High-ranking North Korean officials were present, barking orders as the *Pueblo*'s crew were bound, blindfolded, and beaten. When the ship arrived at the dock in Wonsan, the 83 American prisoners were paraded off the ship to the cheers of a gathered crowd.

The United States never sent the promised air support, but in the days that followed, the U.S. Navy began amassing a Task Force in the Sea of Japan. The U.S. demanded the return of the *Pueblo* and her crew, but the DPRK government refused to comply. The U.S. considered a daring raid of the North Korean docks, but military experts predicted very little chance of success. Undoubtedly the crew would be executed immediately in the event of an attack, and the DPRK's Communist allies would almost certainly rise to defend their sister country. Though contingency plans included the use of military force, it was ruled out as means to recover the crew alive. President Johnson begrudgingly ordered that no strike take place as he explored diplomatic solutions.

Over the following weeks the military stalemate was punctuated by a series of photos, films, and letters depicting the crew of the *Pueblo* enjoying their comfortable stay in North Korea. On the surface, these communications seemed to indicate that the crew had willingly defected to the DPRK, but they contained numerous oddities. In letters home the crew members reminisced about events that had never occurred, they used archaic words in press conferences, and they appeared in a curiously large number of photographs with their middle fingers extended to the cameraman.

In order to spare his youngest crew member from execution, Commander Bucher agreed to sign a "confession" stating that the *Pueblo* had been in North Korean territorial waters at the time of the attack. All the while the men continued to subtly use "the finger" to signal to the U.S. that the photos were staged propaganda. The North Koreans were unfamiliar with the Western gesture, though after it appeared in many photos they asked the Americans about it. The *Pueblo*'s crew had agreed in advance to describe it as the "Hawaiian good luck sign," and their captors seemed to accept that explanation.

In October 1968, *Time* magazine published a photo of the prisoners displaying their "Hawaiian good luck sign," and from the photo's caption the DPRK military learned that the gesture was one of "obscene derisiveness and contempt." This discovery infuriated the North Korean captors, bringing about a period of brutal torture and beatings that came to be known as "Hell Week."

On December 22, after 11 months of captivity, the crew of the USS *Pueblo* were told that the U.S. had decided to apologize for their ship's trespass into DPRK waters, and that they were to be freed. Although the Americans suspected that the story was a ruse designed to demoralize them, they had no choice but to cooperate. The following day, the 82 surviving crew members were loaded onto a train under armed escort and sent southward. The train's last stop was at "The Bridge of No Return," a bridge that spans the demilitarized zone between North and South Korea. The crew crossed cautiously, wary of a trap, but they reached the U.S. forces on the other side without incident. The Koreans' story had been true: In order to expedite the prisoners' release, the U.S. had provided North Korea with a written



■ Captain Lloyd Bucher defends himself in front of the Navy Court.

THE EYES TELL ALL

In the summer of 1965, shortly after the beginning of the Vietnam War, American naval pilot Jeremiah Denton was shot down while on a bombing mission over the city of Thanh Hoa. He was captured by the North Vietnamese and tortured while being held as a prisoner of war.

At one point in 1966, Denton was to be interviewed by a Hanoi television station for the purposes of propaganda; he was given a list of answers and warned not to stray from the script. Upon learning about all of this, Denton realized the camera could afford him a chance to send a secret message. In an inspired moment, Denton realized that any binary (i.e., on/off) system can be used to transmit Morse code, including eyelids. Over the course of the interview session, Denton managed to repeatedly spell the word "torture" by blinking at short and long intervals.

Once the resulting video reached the United States, the U.S. Naval Intelligence detected the subtle message right away. Partially as a result of this resourceful and informative action, Denton was awarded the Navy Cross after being released from captivity and returning home in 1973.



■ After his naval career ended, Denton went on to become a U.S. Senator from Alabama.

admission that the ship had been spying, as well as an official apology. Once the crew members were secured, however, the United States quickly retracted the admission and apology. Upon their return to the U.S., the crew of the captured ship was greeted by a cheering crowd of flag-waving supporters.

Commander Bucher and his crew appeared before a Navy Court of Inquiry regarding the *Pueblo* matter, and after extensive testimony a court martial was recommended for Bucher and the Officer in Charge of the Research Department, Lieutenant Steve Harris, on the grounds that they allowed top-secret equipment to be taken without substantial resistance. Upon hearing this news, the Secretary of the Navy rejected the notion outright, stating, "They have suffered enough."

The U.S. military publicly downplayed the value of the compromised equipment and intel-

ligence aboard the *Pueblo*, but in the years that followed, the Koreans' Soviet allies made dramatic improvements to their own communications technology. Today the USS *Pueblo* still resides in the North Korean capital of Pyongyang, where it is celebrated as one of the country's most popular tourist attractions. Tour guides describe how the imperialist Americans buckled under the Korean people's "unyielding fighting will and indestructible strength."

Many members of the *Pueblo* crew still survive today, though Commander Bucher died in 2004 due in part to injuries sustained while in captivity. As for the *Pueblo* herself, while she remains at anchored in Pyongyang, the American military—perhaps as its own way of giving the North Koreans the "Hawaiian good luck sign"—still lists the USS *Pueblo* as a commissioned ship of the U.S. Navy.



VASELINE'S HEALING POWER

How a grimy by-product of oil production came to be used by millions as a cure-all

Most households in the civilized world, either near at hand or buried in the depths of a neglected medicine cabinet, harbor a small plastic container of processed petroleum waste. Clear and odorless, it has its origins in the sticky goo that sticks to an oil rig and gums up the works. In its natural state it's a muddy gray, with a harsh mineral scent. However, with adequate processing it becomes translucent, smooth, and odor-free. The refined product founded an industrial empire, bequeathed wealth and long life upon its inventor, and has served in all of mankind's great undertakings from the space program to saving chickens from frostbite. This magic substance is known as Vaseline.

The name Vaseline comes from the German word for water and the Greek word for oil—an odd linguistic pairing that ought not mix. The inventor, Robert Chesebrough, was a chemist and purveyor of illumination oil in England. After years of working with whale oils, he determined there was greater wealth to be had in dealing with petroleum. In 1859, at the age of 22, he spent his life savings on a ticket to Titusville, Pennsylvania, to meet with the oil barons there. While touring the vast oil fields, he noted a rig worker scraping thick, dark goo from an oil pump's joint and then applying it to his arm. Upon inquiring, Chesebrough learned that the oil man had burned his arm and that the waxlike gunk tended to come up with the crude and collected on the rigging—if it wasn't cleaned off periodically, the sludge would hinder the

machinery. Some people were convinced that this muck helped wounds to heal faster. Chesebrough quickly made off for England with a bucket full of this "rod wax."

Seeing how the rod wax was considered worthless, he knew that he could make a large margin on it. Being a chemist, he quickly set to work purifying and clarifying the substance. Even with his technical expertise, it took him ten years to perfect the colorless, odorless gel the world is accustomed to today. It was a breakthrough at the time; in the late 19th century, the only lubricants available were lard, goose grease, some mustard plasters, and olive and garlic oil—all of which are organic and have a habit of quickly becoming rank. At the very least, Chesebrough's petroleum jelly had a future in replacing the obsolete greases that came before.

To test the oil worker's claim of medicinal value, Chesebrough chose to test his invention upon himself. He would cut, stab, burn, and apply acids to his own skin so he might treat the injuries with the wonder salve; he was generally pleased with the results. He opened the first Vaseline factory in 1870 and obtained a patent in 1872. Now, the only problem was finding buyers.

He took his creation out to pharmacies and held small displays for potential customers. Chesebrough would reveal his injured arms to be a testimony to Vaseline's healing prowess. Nevertheless, there was no surge of interest. Perhaps his lack of a control group fueled skepticism for the claims, or perhaps people were wary of any medicine that wasn't overtly unpleasant.

With no luck locally, he took his invention on the road. He gave Vaseline away at the end of roadside demonstrations. People took the product, then after using up the free supply, went to their pharmacists to procure more. Of course the pharmacists had none. Having spurned it before, they now began ordering bottles of the ointment in huge quantities. Though Vaseline's first major success came as a medicine, it was later proven that its only healing property was its ability to keep grime and bacteria out of injuries.

Vaseline soon became a household word. Robert Peary took some on his expedition to the North Pole. It was used on the teeth of beauty pageant contestants to make their smiles bright. It was shown to control unruly hair and prevent frostbite on the combs of chickens. It could soothe infant bottoms and be used to soften dry, scaly elbows. During a bout of pleurisy, Chesebrough ordered himself drenched top to toe with Vaseline. He soon recovered completely, and credited his invention for saving the day. Shortly before his death in 1938, Chesebrough revealed that he'd been eating a spoonful a day for several years—he was 96 when he died, so obviously the ingestion of rod wax did him no harm.

Is there anything that Vaseline can't do?



■ Excessive application makes baby difficult to hold.



VESNA VULOVIC'S LUCKY DAY

A flight attendant boards a flight she wasn't meant to be on and ends up the sole survivor of a terrorist attack

On January 26, 1972, a 22-year-old flight attendant named Vesna Vulovic was not where she was supposed to be. She was cruising at 33,330 feet above Czechoslovakia (now Czech Republic) in a DC-9 airplane on a flight from Copenhagen to Zagreb. Her schedule had been mixed up with that of another stewardess also named Vesna, and she was subsequently placed on the wrong outgoing and return flight. Vesna was happy for the mistake; it had afforded her the opportunity to see Denmark and to stay in a Sheraton Hotel, which she had always dreamed of doing. But the mix-up turned out not to be as fortuitous as it first seemed.

Unbeknownst to Vesna, a terrorist group known as Ustache had placed a powerful explosive on this particular plane. The Ustache was a far-right Nazi/fascist group in Croatia that had been implicated in more than two dozen terrorist attacks against Yugoslavia after World War II. Vesna's flight—JAT Yugoslav Flight 364—was with an airline based in Yugoslavia.

While passing over the city of Srbska-Kamenice, the explosive device detonated. The DC-9 was torn into pieces, and the plane's wreckage, along with its 28 passengers, fell through the sky for three long minutes before crashing into a frozen mountainside.

A German man named Bruno Honke was drawn to the scene by the sound of wreckage hitting the ground. Upon arriving at the crash site, he found all of the plane's passengers dead—save one. Amazingly, Vesna was still breathing. She was lying half outside of the plane with another crew mem-

ber's body on top of her and a serving cart pinned against her spine. Honke had been a medic in the Second World War and did what he could for her until further help arrived.

The DC-9 was torn into pieces, and the plane's wreckage, along with its 28 passengers, fell through the sky for three long minutes before crashing into a frozen mountainside.

At the hospital, her parents were told that although there was still life in her body, she would not survive. The 33,330 foot fall had left her skull broken and hemorrhaging, both of her legs were



■ *Vesna Vulovic before her fateful flight.*

broken, and she had three crushed vertebrae. But miraculously three days later, she awoke from her coma and asked for a cigarette.

Vesna was paralyzed from the waist down, but against all odds she was alive and conscious. Two weeks after the accident, her doctor told her what had happened and gave her a newspaper to read the story, but the memory of this event would escape

her, as did everything from one hour before the accident to one month after. Later she underwent surgery that restored movement to her left leg, and a month after that, she regained movement in her right leg. Eventually she was able to walk again.

By the following September, she was eager to go back to work, but the airline gave her a desk job to avoid publicity. She never suffered any psychological trauma as a result of the incident and never experienced any fear of flying. She is still alive today and flies frequently. She has a positive philosophy on life, stating, "I believe we are masters of our lives—we hold all the cards and it is up to us to use them right."

Her good fortune in surviving the incident is most likely due to her low blood pressure, which caused her to pass out quickly and prevented her heart from bursting. But despite this, Vesna does not consider herself lucky. Thirty years after the crash, she said to Philip Baum in an interview, "I'm not lucky. Everybody thinks I am lucky, but they are mistaken. If I were lucky I would never had this accident . . ." Indeed the assertion that "it could be worse" is small comfort to the pragmatic, because certainly it could also be *much better*.

Vesna currently holds the Guinness World Record for the highest fall survived without a parachute, at 33,330 feet.

WHEN GRAVITY DOESN'T WORK . . .

In 1930 five glider pilots were caught in a thunderstorm over the Rhône Mountains. Their delicate aircraft stood little chance of surviving the raging maelstrom, so they ejected in the hopes of weathering the storm from the ground. Much to their surprise, they were yanked skyward by powerful winds, and the pilots soon found themselves covered in a thick layer of ice. Though all their parachutes opened, only one man survived the ordeal. The other four had become "human hailstones" by the time they touched down—frozen solid and caked in ice.

WALKING CORPSE SYNDROME

It's not easy being a zombie ...

The patient was brought in earlier today. His family says he's been refusing food and uttering strange things for months. They tried to deal with it at home, but when he began harming himself, they decided it best to bring him in to see us.

"So, Mr. Mayhew, let's have a talk about some of the issues you've been having. I heard you've been acting strangely for the last few months. Your record says you've been in for depression before, but nothing particularly serious. Would you mind telling me what you think is going on?"

"Well, doctor, it's actually quite a few things, but if I had to narrow it down, I'd say my biggest problem is that I'm dead."

The human brain is capable of staggering feats of intellectual achievement and complexity. It orders, structures, and filters the constant bombardment of stimuli that the average day heaps upon us. Sometimes a brain can't reconcile the information it's being sent with the inner framework that's been built to organize that information. When this happens, the brain finds ways to compensate. One of those ways is what is commonly called delusion.

Cotard's Delusion—also known as Walking Corpse Syndrome or Negation Delusion—is marked by the outlandish and unswerving belief that one is dead. How the sufferer thinks that he died varies: Many claim that an outside agent killed them, oftentimes their own family. Others come to the conclusion slowly, as if being dead is something easily overlooked in the hustle and bustle of modern life.

The condition is named for Jules Cotard, a French neurologist who originally described it in

1880. At a lecture in Paris of that year, he said of his findings:

“In all the patients the hypochondriacal delirium introduces great delusions: Their brain, stomach, heart, blood, spirit, and/or body are missing. They are damned, the organs do not exist, the body is reduced to a mere machine. The delusions may include religious, metaphysical, and abstract ideas of persecution. To such ideas, delusions of immortality may come to be included. Along with or following the ideas of immortality may come ideas of body expansion in space: They are immense, their dimension is gigantic, they can touch the stars, they may feel possessed by powerful demons, their head expands until it occupies an entire church. At times the body no longer has limits, it extends to the infinite and it disperses in the universe.”

At the time he referred to the disease as "negation delirium." Only later was his name attached, in

honor of his earlier work. There is evidence that the delusion may have been described even earlier—as far back as the 1700s—but Cotard receives most of the recognition based on his introducing it to modern science.

"I see. Now, can you please explain to me what you mean when you say you're dead? You're speaking to me, breathing, and, while perhaps a bit tired-looking, seem very much alive."

"I can't really pinpoint when it happened. Everything just started to feel wrong. I couldn't place my finger on it until one day I realized I was dead. My organs aren't working. My bowels are blocked, so I can't eat. My blood is dried up."

"Your family says you began cutting yourself this morning. They said that's why they brought you in. Care to explain?"

"No one believes me. They keep worrying about me and telling me to eat. I was just trying to prove to them that I'm dead so they'd stop bothering me about it."

Walking Corpse Syndrome can arise when a person undergoes severe depression, often in tandem with neurological conditions such as epilepsy, head injury, sleep disorders, or schizophrenia. It can also be exacerbated by traumatic events.

The most common complaint of the sufferer—outside of the inconvenience of being dead—is that their body has stopped working. Many insist that their organs are missing altogether. Others speak of an inability to think due to their rotting brain. Most are sure they can't perform normal functions like eating, speaking, or defecating. They become a literal shell; a physical representation of their mental self.

Some Cotard's patients have been known to lash out violently. While rare, usually the violence is directed on themselves, often in an attempt to prove their claims to disbelieving family or friends.

"You seem remarkably calm for someone who's so conscious of their own demise."

"Well, I can't do much about it, can I? I'm not even really here, I'm just watching all this life



■ "Just because I can walk doesn't mean I'm alive."

happen around me. It's like watching a movie from the inside."

A powerful sense of apathy is usually felt by sufferers of Cotard's Delusion. This stems from patients' alienation from the world they see around them. It's theorized that when the initial changes that bring about the delusion occur, the way the patient's brain chooses to interpret those changes is indicative of what route the disease will take. In some cases, the patient will externalize the changes and assume that something in the world around them is different. These people often suffer from Capgras Syndrome (see page 34), the delusion that one's family and friends have been replaced by impostors. Other times, the patient will internalize the changes and assume that something within themselves is the cause. Research shows that most Cotard's patients also suffer from depression and tend to be left with it even after their delusions are cured. As people suffering from severe depression are prone to bouts of paranoia and self-loathing, it's believed that this is the trigger for the patient to internalize rather than externalize their problems.

It is common for Cotard's sufferers to stop referring to themselves in the first person, linguistic evidence of their minds' continuing descent into delusion. As they view themselves as less and less a part of the world around them, they actually begin viewing the world as an outside narrator. Another outward expression of this profound sense of solitude is an inability to feel. Patients say they can't experience pleasant smells or hear everyday sounds. Some claim to be only able to see shadows or outlines of their surroundings, others complain that food tastes of ash.

"It seems everything is in order then. One more question, though. How do you feel about telling me these things? Do you think I believe you or not?"

"I don't know how I feel about telling you. I'm completely sure I'm correct, and yet, if I were you, I wouldn't believe me. I don't blame my family for how they've reacted, because I'd probably react

the same way. I'm still not sure why I even believe it myself."

The Cotard sufferers' ability to distinguish between the life and death of others is often completely untouched. While convinced that they are a walking corpse cursed to an eternity of wandering, they simultaneously understand that the rest of the world functions as normal. Many express an understanding of the reasons why no one believes them. The ability to objectively understand the preposterous nature of their claims shows a presence of mind that is surprising considering the very serious nature of their illness.

Patients say they can't experience pleasant smells or hear everyday sounds. Some claim to be only able to see shadows or outlines of their surroundings, others complain that food tastes of ash.

One of the most fascinating aspects of Cotard's Syndrome is that the symptoms often manifest themselves in culturally specific ways. Sufferers in the Western world may explain their feelings of alienation using stories that involve robots or computers. Others will use their religious beliefs as a framework to explain the changes in their psyche. Patients often talk of being cursed by God. One elderly woman believed her family were wicked people for not having buried her properly after her death. Every night she demanded to be laid to rest in full burial shroud, and every morning she woke annoyed that her family would not fulfill her wishes and leave her in peace.

A particularly powerful example of the cultural specificity of Cotard's Delusion is the case of an

THE CURE WILL COST AN ARM OR A LEG

Everyone has on occasion felt incomplete, but for those with Body Integrity Identity Disorder (BIID) the intensity is much greater. Sufferers of this disorder attribute the source of their despair to one of their own limbs. In a truly bizarre desire to feel "whole," they emphatically desire to have a healthy limb amputated.

Often the patient has a distinct notion of which limb they wish to lose, such as the leg amputated above the knee, or an arm below the shoulder. Few doctors will give any consideration to such a patient in healthy physical condition. This has prompted some BIID sufferers to irreversibly damage their limb in an effort to leave doctors with no option but to fulfill the patient's desire for amputation. There are reports of people freezing limbs in dry ice and creating wounds with deliberate infections, and some have even shot the limb off.

Some believe BIID to be an acute demonstration of Munchausen Syndrome, whereby the individual feigns or creates symptoms of illness to gain attention and sympathy. Many who suffer from BIID describe a keen awareness that their desire to lose a limb is a bizarre one, simultaneously exhibiting *acrotomophilia*, a strong sexual attraction to amputees.

Scottish Surgeon Robert Smith has completed amputations for two otherwise healthy people, prompting the National Health Service in the U.K. to ban the procedure. Smith, however, felt that "The patients had had very little success from their treatments by psychiatrists and psychologists over the years" and "surgery was the only redress."

Iranian man. While he exhibited classic symptoms, he also believed that he and his wife had been turned into dogs. He was further convinced that his three daughters' urine smelled like sheep, and took this as proof that, along with his own metamorphosis, they were now hooved field-grazers. The authors of the study believe the delusions were the man's way of coping with a sexual attraction to his daughters. Wolves are traditionally known as the guardians of sheep, and in Persian culture are known for loyalty and impurity. This protector/defiler duality is seen to mirror the man's own mixed feelings about his relationship with his children.

As a study in brain functions, Cotard's Syndrome—and Capgras, its sister disease—offers interesting conclusions about the origins of delusion and how they relate to the functions of "normal" brains. Both diseases indicate that the brain develops a hypoth-

esis to explain strange perceptual phenomena in exactly the same way a normal person develops ideas. When a part of the brain stops working correctly, it quickly finds ways to explain the change. With Cotard's patients, the strange feeling of isolation becomes a belief that the body has stopped working altogether and that they are no longer among the living.

Cotard's Syndrome has all but disappeared in the 21st century. A combination of effective treatments and early detection have made it a neurosis largely confined to the annals of history. Electroconvulsive therapy has proven quite effective, and the early treatment of depression in the modern world has undoubtedly cured many cases before they had time to mature. Even if a case of Cotard's Delusion is never seen again, it stands as a fascinating reminder of the lengths the brain will go to make sense of the world around it.

WEIRD WEAPONRY

When it comes to inventing new modes of attack, militaries around the world have come up with more than a few bizarre ideas

In their drive to kill, maim or incapacitate their fellow man, some militaries will entertain almost any half-baked idea if they think it could have merit on the battlefield. These concepts usually die before making it far, but not before wasting considerable taxpayer money. A few even find their way well into development before the designers finally have some sense knocked into them.

THE IMPLAUSIBLE

FLYING TANKS In the aftermath of the Nazi assault on the USSR, Soviet military leaders were looking for an effective way to get behind enemy lines. A flying tank seemed the obvious choice. The result was a modified Soviet T-60 tank fitted with wings in an attempt to make it airworthy. While it received a good review in its only test flight, it was never to see active service. In addition to the Soviet's lack of a good heavy aircraft to tow the KT-40, the tank also had to be stripped of much of its armor to keep its weight down. Even if the hybrid fighting vehicles were able to reach the enemy's rear, the lightly armored tanks would be quickly pummeled by the experienced and heavily armored Panzer crews they were designed to fight.

THAT IS A GUN IN MY POCKET The FP-45 Liberator was a tiny single-shot pistol developed by the U.S. in 1942. A million were manufactured and assembled at \$2.40 each, then air-dropped into occupied China and the Philippines. The crude weapon was intended to demoralize the occupying Axis forces by creating a sense of dread, since any citizen could be lethally armed. The gun's production proceeded under an umbrella of secrecy by disguising parts and plans as a .45-caliber flare gun. Although some of the Liberators were distributed to resistance fighters in the Pacific theater, there's no evidence that any of them actually saw use.

ICEBERG WARSHIP As German U-boats pounded the ships of the British Navy during World War II, the Brits became desperate to build a ship that could take more torpedo punishment. The *Habbakuk* was destined to be a two-million-ton aircraft carrier with a hull 40 feet thick—made almost entirely of ice. More specifically, it was to be made out of Pykrete, an

extra-strong variety of ice reinforced with cellulose in the form of sawdust, wood chips, and paper shreds designed for the project. A small-scale prototype proved that the armed-iceberg concept was solid, however the construction of the monstrous *Habbakuk* was mothballed once it became apparent that the reallocation of wood pulp, steel framing, and insulating cork would severely impact other wartime efforts.

EXPLODING BALLOONS Lacking a practical means to attack the U.S. mainland during World War II, the Japanese constructed 9,000 large hydrogen balloons, attached incendiary and antipersonnel bombs to them, and set them afloat on the trade winds. About 1,000 of these weapons successfully crossed the 6,000 miles from Japan, a few drifting as far east as Michigan. Once the U.S. military realized the nature of these balloons, they regularly shot them out of the sky, but adopted a policy of absolute secrecy to deny the Japanese any news of success. After five months, the Japanese became discouraged by the bombs' apparent total failure and halted the attacks. The policy of silence was so successful that few people have heard of these bombs even today. In all, there were 285 balloon bomb incidents reported, and six deaths. All six deaths occurred when a group of picnickers in Oregon found a balloon bomb in the woods and attempted to move it, causing it to explode.



THE COMICALLY DOOMED

STINK BOMBS In 1994, researchers working for the U.S. Air Force proposed a "gay bomb" filled with a synthetic aphrodisiac meant to turn anyone exposed to it into a hopeless homosexual. The plan was abandoned when military laboratories were unable to formulate such a chemical. There have also been a number of body odor bombs discussed in committee debates, including a halitosis bomb and a flatulence bomb. Although none have made it any further than the theoretical stage, they all work on the same concept: They would greatly demoralize the enemy and inhibit their ability to wage war. The fact that they're hilarious is just an unintended perk.

TRICYCLE TANK Like something out of a Monty Python skit, the Tsar Tank was Russia's most ill-omened foray into the world of tank warfare. Built on a tricycle design rather than the caterpillar track that most tanks utilize, its two massive front wheels stood almost 30 feet high. In the vein of old-time bikes, its huge front wheels were offset by a single back wheel only five feet in height. Even apart from its odd appearance, the tank proved unwieldy in testing. It lacked in firepower and armor, and was prone to getting stuck on uneven ground or in mud. In 1915, after being proven a disastrous idea, the sole prototype of the Tsar was left where it stood. After nearly a decade of inactivity at the test grounds near Moscow, it was unceremoniously disassembled for scrap metal in 1923.

THE FRIGHTENINGLY POSSIBLE

ATOMIC ANNIE In 1953, an explosion obliterated a small section of the Nevada desert. In its wake were collapsed bridges, husks of buildings, and vehicles torn to shreds. The culprit was Atomic Annie, an 800-pound nuclear artillery shell packing a payload equivalent to 15,000 metric tons of TNT. Designed as a small-scale version of its city-leveling cousins, Annie proved even more destructive than its creators anticipated. When her shell exploded, it created an expected "precursor" wave that inherited the projectile's forward momentum, shredding, upending, and disintegrating everything in its path. Annie was so powerful, in fact, that its test firing caused decidedly more damage than a bomb twice its payload that was tested two weeks earlier.



■ A house gets completely obliterated by Annie's force.

EVIL NOISE A new class of weaponry based on high-intensity sound waves shows considerable promise, according to recent research. These sonic weapons are capable of inducing anything from slight nausea to complete incapacitation. It's even theorized that a powerful enough blast could prove lethal via the liquification or disintegration of the target's body tissue.

RODS FROM ON HIGH "Rods from God" is the nickname of a satellite weapon system that may or may not be officially in development. It consists of a pair of satellites working in unison: one doing the targeting and the other firing a 20-foot-long by 1-foot-wide tungsten rod. These rods would travel at 36,000 feet per second, striking the earth with the force of a meteor. Even hardened bunkers and underground fortifications would be unable to withstand such monumental punishment. In an Air Force report from 2003, "hypervelocity rod bundles" were listed in a space-weapons program outline, hinting that this system may not be as far off as we think.

ZERO RECALL

How one man's memorable misfortune dramatically advanced the field of neuroscience

I don't remember things," Henry explained to the unfamiliar female interviewer. She was very curious about how he spent a typical day, where he lived, and what he had eaten for breakfast, but his efforts to summon the information from his mind were futile. He could easily answer her questions regarding his childhood and early adult years, but the indefinite expanse of time since then was bereft of memories. In fact, from moment to moment Henry felt almost as though he has just awakened from a deep sleep, with the fleeting remnants of a dream always just beyond his grasp. Each experience, dull or dramatic, evaporated from his memory within a few dozen heartbeats and left nary a trace.

For over fifty years Henry lived with *anterograde* amnesia, a form of profound memory loss which prevented new events from being committed to his long-term memory. As a result his only memories were those he possessed prior to his amnesia, and the small window of moments immediately preceding the present.

For the most part, the amnesia depicted in fiction and movies is a very rare *retrograde* variety known as dissociative fugue, where one's identity and all memories prior to a pivotal event are compromised. In contrast, anterograde amnesia does not deprive the sufferer of his or her identity, past, or skills; it merely prevents new memories from forming. As a consequence the



memories from before the mind-compromising event are frozen in perpetuity, often accompanied by a constant sensation that one has just awakened from some sort of coma.

Henry's handicap was the unintended result of experimental brain surgery performed in 1953 at age 27. In his late teens the highly intelligent student began to experience frequent grand mal seizures, characterized by loss of consciousness, muscle spasms, and rigidity. The frequency of these epileptic events increased to the point that he was stricken with spontaneous episodes of uncon-

■ *Paradoxically, most patients suffering from anterograde amnesia are aware that they can't remember things.*

sciousness every few minutes. After exploring every other avenue known to medicine at the time, Dr. William Scoville administered a radical resection of the man's medial temporal lobes in a desperate bid to reclaim some quality of life for young Henry. In that respect the experimental operation was a success—the patient's severe seizures were reduced dramatically after the operation—however the surgeon was distressed to discover that the removal of the hippocampi had stripped Henry of his ability to form new memories.

H.M.'s handicap helped to propel memory research beyond the realm of the philosophical for the first time in history.

The development seriously hindered Henry from pursuing a normal life, but due to his condition he quickly became the world's most famous subject in the study of the human brain. His real identity was kept a closely kept secret, being referred to only as "H.M." in the substantial corpus of medical literature that his condition brought about. However unfortunate, H.M.'s handicap helped to propel memory research beyond the realm of the philosophical for the first time in history. Earlier efforts to explore memory had been limited to animal studies, where scientists deliberately damaged various regions of lab animals' brains to monitor any loss of memory functions. Such experiments were not only unpleasant for the animals, but frustratingly inconclusive for the researchers.

H.M. was described as a friendly and articulate man with a higher-than-average IQ, sporting a charming personality in spite of his condition. Even as an octogenarian he could vividly recall events from his childhood such as the stock market crash of 1929. But he was stricken with renewed

grief every time he learned of his mother's death, which occurred sometime after his mind-altering surgery. The grief was short-lived, however, as the substance of the news soon slipped from the feeble grasp of his "working memory." In an interview with researchers, he described the sensation:

"Right now, I'm wondering, have I done or said anything amiss? You see, at this moment everything looks clear to me, but what happened just before? That's what worries me. It's like waking from a dream. I just don't remember."

Like most anterograde amnesiacs, Henry experienced a degree of retrograde amnesia as well, blurring the details of the months leading up to the fatal operation.

Similar cases of anterograde amnesia have appeared in the intervening years, often caused by Korsakoff's Syndrome, a thiamine (vitamin B₁) deficiency brought on by chronic alcoholism, malnutrition, eating disorders, or poisoning. This strongly suggests that thiamine is necessary to maintain the memory-writing features of the brain. Some abnormal viral infections can also produce the affliction, as is the case with a famed music expert named Clive Wearing. His ability to store memories was destroyed by a rogue infection of the *herpes simplex 1* virus which attacked his brain's hippocampus rather than triggering the typical cold sores. Other known causes include brain tumors, oxygen deprivation, and dementia-related diseases such as Alzheimer's. In each instance it is found that one or both of the brain's hippocampi have been damaged, indicating that these small structures are vital in laying down long-term memories. These brain circuits do not seem to play a role in recalling existing memories, however, since stored memories remain inaccessible even when the hippocampi have been compromised.

Though anterograde amnesiacs are blocked from storing new information, researchers were astonished to discover that subjects are nonetheless

less capable of mastering new and complex tasks over time. Subjects who repeatedly practice skills such as backwards writing or guitar-playing can demonstrate measurable improvement, though in

first time. One one occasion, however, a nurse mentioned to Henry that "Dr. Corkin" had been asking about him, and he responded by asking, "Suzanne?" Though he could not say who she was, he had somehow managed to associate her first and last names.



■ The protagonist, Leonard, in the movie *Memento*, uses a system of notes, photographs, and tattoos to cope with his anterograde amnesia.

each instance the subject believes that he or she is attempting the task for the first time. This insight cast serious doubt upon the long-held belief that all memory is stored in a common mental reservoir. It also demonstrated that procedural memory—the "how-to" memory of motor skills—is not governed by the exact same circuitry as episodic memory (autobiographical events) and semantic memory (general knowledge and facts). Additionally, some patients have experienced the "Tetris Effect" hours or days after playing the game during experiments; they describe vivid dreams of falling Tetris shapes although they possess no conscious memory of the game's existence.

A neuroscientist named Suzanne Corkin worked very closely with Henry M. for about forty-three years, but each time she introduced herself he greeted her as though he was meeting her for the

seemed untroubled by the 82-year-old face which stared back at him from the mirror in 2008. This suggested that he had some degree of awareness of the decades that had passed. When asked what he thought about how he looked, he responded matter-of-factly, "I'm not a boy." He also somehow managed to learn that his memory was broken, and that scientists were studying him to discover more about the human mind. Once, when asked whether he was a happy person, Henry responded "Yes" without hesitation. He followed with, "The way I figure it is, what they find out about me helps them to help other people."

Small talk with H.M. tended to be a bit repetitive, but occasionally revealing. During a visit to the Massachusetts Institute of Technology to conduct memory tests, Dr. Corkin asked Henry if he knew where he was as they strolled down a nondescript

corridor. "Why of course," he replied with a grin, "I'm at MIT!"

Taken aback, Dr. Corkin asked, "How do you know that?"

Laughing, Henry pointed at a nearby student wearing an MIT sweater. "Got you that time!"

Not only did the event demonstrate his intact sense of humor, but it showed that his powers of deduction were unhindered by his memory malady. On another occasion Henry was asked what he does to try to remember things. "Well," he replied with a chuckle, "That I don't know 'cause I don't remember what I tried."

In a rare example of scientific correctness in Hollywood, the reality of anterograde amnesia was depicted with reasonable accuracy in the 2001 film *Memento*. The filmmakers applied the concept of reverse chronology to mimic the effects of the condition, allowing viewers to share in the protagonist's confusion regarding prior events.

Owing to his unfortunate ailment Henry M. was never able to understand the inestimable gift he has given to the field of neurology. The amnesic octogenarian resided in a Connecticut nursing home for most of his life, helping researchers to coax secrets from the human mind right up until his death in December 2008. On that melancholy day, the world finally learned the name behind so much of our modern neurological knowledge: Henry Gustav Molaison. Henry's lifelong contribution to science did not cease upon his death, however; he and his court-appointed guardian had agreed to donate his brain to science so that brain scientists may examine the offending lesions in detail, and further advance our understanding of the human mind. Though science is still rife with questions regarding memory's machinations, Henry and other sufferers of anterograde amnesia have provided a considerable number of indispensable clues. Their unwitting contributions will not be soon forgotten.

CONTRIBUTORS

A LAN BELLOWS was born in 1977 in Provo, Utah. From the moment his brain was able to comprehend written words, he commenced consuming books by the fistful. After almost three decades of filling his head with fascinating facts he established DamnInteresting.com, an outlet for engrossing, true stories from the past, present, and anticipated future. When not writing, Alan spends much of his time illustrating, programming, web-developing, photographing, and/or motorcycling. He presently resides in Utah with his wife Brittany. Oh, how they scoffed when he strayed from the Internet to try his hand at quaint paper publishing . . . but who's scoffing now? Scoff, scoff, scoff!

JASON BELLOWS was born and reared in Orem, Utah. At a young age, Jason was accidentally exposed to industrial strength science fiction, which imparted upon him a preternatural propensity for reading and science. Through the years Jason has dabbled in martial arts, culinary arts, skydiving, lucid dreaming, bungee jumping, spelunking, and covert acts of superheroism. He continues to live in Orem with his lovely wife, and uses his writing prowess to inflict his sci-fi vice upon others.

MARISA BROOK grew up in British Columbia and graduated from Cornell University in 2009. Up next for her is grad school, meaning that she will continue to be unconvinced that there exists such a thing as free time. However, if she were ever to come across evidence to the contrary, she'd probably spend this time reading, writing, composing music, lurking in bookstores, and occasionally doing outdoorsy things such as hiking, rock-climbing, and canoeing.

MATT CASTLE was born in England and currently lives in London, making him the first and so far only non-North American Damn Interesting writer. His interests include reading, writing, travel, photography, film, history, health, aviation, space, and science. Although he is in his thirties and has a respectable day job, he is still having trouble deciding what he wants to do when he grows up.

SCOTT CIANCIOSI was born and raised in Buffalo, New York. He has a Master of Arts in English Literature and is currently teaching at a university in Seoul, South Korea. He enjoys pretty much everything, from reading and writing to travel, computers, and music. The last couple of years have found him inordinately interested in space and theoretical physics. He'd like to thank his mother for getting him into Frank Herbert, and his father for raising a kid who could speak at length about Civil War-era generals.

ANTHONY KENDALL currently resides with his wife and daughter in Lansing, Michigan, where he just finished his PhD in the geosciences at Michigan State University. From a very young age, he was impressed by the way his grandfather could spin an engrossing story around nearly any subject, and resolved to someday acquire that talent. A quick scan of his bookshelf reveals a fascination with science, and he feels tremendously lucky to have found a career as a scientist. He hopes his writing inspires a curiosity about science in others.



RYAN J. LOWDER was born in Utah, and has spent most of his life there with the exception of two years in Norway. His brain bears the early marks of the Bookmobile and PBS television. Following Twain's adage, he never let his schooling get in the way of his education, although he let it get in the way of pretty much everything else. This schooling habit led to one bachelor's degree in electrical engineering and one-and-one-half master's degrees in biology. Hobbies under development include electronics, mushroom culturing, and digital holography; he pursues each until distracted by something shiny. He is currently a bioengineer living near Salt Lake City, Utah, with his wife and two young children, whom he teaches to blow stuff up.

In addition to my wife, my portion is dedicated to my children Emily Eliza and Thomas B.J. Lowder, and to my sophomore English teacher, Sandy Clark.



GERRY MATLACK is a lifelong (so far) California resident. His interests include such diverse elements as: magic, science fiction, astronomy, roller coasters, spicy foods, avoiding talking about himself in the third person, and slaying dragons. He looks forward to someday catching multiple personality disorder.

I dedicate my portion of this book to the memory of my father, Dennis, who instilled in me a perfectionist streak and a love for sampling the variety of life.



CHRISTOPHER S. PUTNAM lives in Saskatchewan, Canada, where he currently works as a newspaper reporter and freelance writer. In his spare time, he enjoys studying diverse subjects that are both terribly fascinating and exceedingly useless. He is widely regarded among critics as the Damn Interesting writer with the lengthiest moniker.



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YNTHIA WOOD was born in Palo Alto, California, in 1969, but moved to the other side of the country when she was 2 months old. She has continued in a similar vein since then, having lived in more than a dozen homes in ten states. Currently she resides in Indiana with her husband and two sons, where she practices karate, plays the organ, and writes science fiction—except when she forgets to put in the fiction.

WRITING CREDITS

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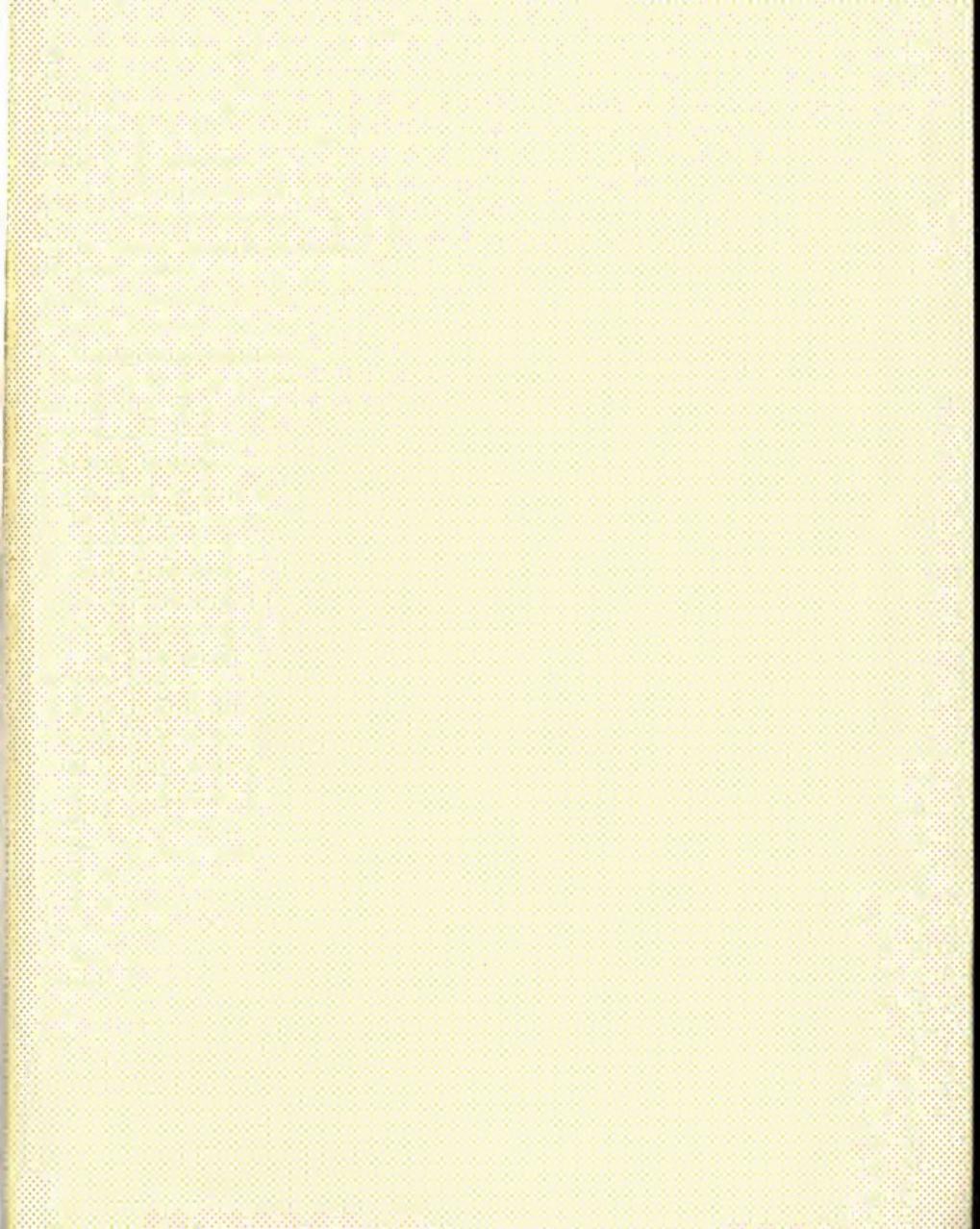
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Alan Bellows is the writer, designer, managing editor, and mastermind behind DamnInteresting.com. A software designer, he developed his fascination for the odd and unexpected during his years working in the library industry. He lives with his wife outside of Salt Lake City.

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